Naval Command,
Control and Ocean
Surveillance Center
RDT&E Division
San Diego, CA
92152-5001

(4)

Technical Document 2452
February 1993

Disturbance Impact Assessment System (DIAS), Version 2.0

System Design Document

R. Rose
D. Lambert

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ADMINISTRATIVE INFORMATION

This report reflects research and development conducted from 1 October 1989 to 30 September 1992 for the Classic PROPHECY Project, NOSC project no. SY35 and project PENEX, NRaD project no. MP91, subproject no. R1947, accession no. DN302027, and program element 0601000N. The work was performed under the Disturbance Impact Assessment System (DIAS) Development Task by members of the Signals Exploitation Branch, Code 772, and the Ionospheric Branch, Code 542, at the Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (NRaD), San Diego, California.

Released by
J. A. Audia, Head
Systems Exploitation
Branch

Under authority of
F. S. Kacer, Head
Signals Warfare
Division

RBT

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1.0 SCOPE

1.1 IDENTIFICATION OF DOCUMENT

The Disturbance Impact Assessment System (DIAS) is a computer software package designed to assess the impact of solar flares on HF radio communications. This System Design Document, or functional description document, describes the DIAS software functions and their interrelationships. Specifically, it

a. provides background information on the impact of high levels of solar activity on high-latitude HF missions;

b. outlines the architecture of DIAS; and

c. explains the product that DIAS provides for the user.

1.2 PURPOSE OF DIAS

The purpose of DIAS is to provide timely advice to users of high-latitude HF circuits (those above 50 degrees north) regarding the probable impact of solar flares on their HF radio communication operations. DIAS is designed to assess the likelihoods of various kinds of ionospheric disturbances caused by solar flares and to make first-order estimates of the effects the disturbances could have on the user's specific high-latitude HF circuits. The DIAS modules provide qualitative advisories and warnings to indicate the direction in which conditions are progressing. Future systems will be capable of providing quantitative solutions in support of Medusa. The system output also provides supplementary explanation in the form of 'BECAUSE' statements. During undisturbed ionospheric conditions, the system is transparent to the user.

Analysis is driven by datalink inputs derived from the solar sensors on the GOES satellites, including solar X-ray flux, solar-proton flux, and geomagnetic indices. When a flare occurs, a real-time clock starts a 120-hour countdown, and DIAS alerts the user. DIAS then evaluates the various effects of the flare as a function of elapsed time. Analysis spans the period from the initial X-ray burst at flare onset (T0 hours) until the effects are expected to subside 5 days later (T120 hours). Over this time, the analysis tracks the possible impact of various ionospheric disturbances, taking into consideration such parameters as operating frequency, time of transmission, and circuit path, to tailor its advice specifically to the user's current mission.

Two versions of DIAS have been built. The first, VPDIAS, was built using the rule-based VP-EXPERT shell. It operates as an

independent stand-alone system on IBM-PC computers and compatibles. The second, FCDIAS, was built using the First-Class decision-tree expert-system tool. It, too, operates on IBM-PCs and compatibles. But it is primarily designed to be integrated with Medusa on a DEC VAX under VMS. It is system-oriented, can be called by another program, and combines the capabilities of an expert system with those of the algorithmic PROPHET HF signal-assessment system.

The ionospheric disturbances for which DIAS ruleset modules have been developed are

1. Sudden Ionospheric Disturbance (SID)

2. Polar Cap Absorption (PCA)

3. Ionospheric Storm (IS)

4. Auroral E (AurE), and

5. Auroral Zone Absorption (AZA).

This document describes each of these disturbance phenomena, including information about its cause and its effects on circuits. It then describes the function of each corresponding DIAS module, detailing the required data input and referencing its basis.

1.3 MOTIVES FOR BUILDING DIAS

Before the development of DIAS, the typical high-latitude HF user was virtually at the mercy of the environment. Even though the NOAA Space Environmental Support Center (SESC), Boulder, CO, can detect solar disturbances, users typically did not have the capability to download the SESC's sensor data in realtime and forecast near-earth effects at high latitudes. Also, capability was not available to provide data to either circumvent or mitigate the degraded propagation conditions for the mission. Typically, HF users experienced a sudden loss of signal or poor signal-to-noise ratios without warning and without any knowledge of how long these conditions would last. The operational user typically has no background either in solar activity or in the effects of the resulting disturbances on high-latitude propagation. DIAS now fills this gap, providing the user with transparent and nearly "hands-off" support.

DIAS employs two decades of high-latitude research and a hybrid software approach to detect solar flares and forecast their effects. However, prediction of the propagation of electromagnetic waves by the ionosphere is still an imprecise science. Much of the information available in this field, particularly that concerning Auroral Zone Absorption (AZA), is best described in a qualitative

or intuitive fashion. This is one of the key factors that make expert-system tools the development environment of choice.

The primary motive behind the development of DIAS is to review and begin to use the wealth of data produced by the two-plus decades of high-latitude research conducted since 1965. Modern technology makes this knowledge more readily usable by the operational community when their communication requirements involve latitudes above 50 degrees north.

A second motive is to preserve valuable knowledge. As support for this science subsided over the past decade, the number of experts in this field steadily diminished. Now, there are fewer persons who can describe the often multiple effects of a solar disturbance on high-latitude signals. The DIAS project seeks to glean information from the remaining experts and to clone this knowledge into a form that is both preservable and directly usable.

A third motive for building DIAS is that the operational community does not understand how disturbed HF propagation at high latitudes works. Furthermore, it is not reasonable to expect communicators to deal with this complex science. DIAS attempts to alleviate this burden by monitoring environmental conditions, making first-order assessments of expected signal degradation, and issuing advisories to the Medusa system user at the appropriate times. This information allows the user to distinguish between hardware problems and environmental factors as the source of signal changes. DIAS thus assists HF users in knowing when environmental effects are degrading their system's performance and in estimating approximately how long the effects will persist.

An auxiliary motive for which the VPDIAS version of DIAS was built is to provide a tool for teaching users how solar flares affect their systems.

2.0 REFERENCE DOCUMENTS: DIAS TECHNICAL LITERATURE SEARCH

This literature search provides the background for development of the **Disturbance Impact Assessment System (DIAS).** During the past 20 years, substantial research on solar-terrestrial and solar cause-and-effect phenomenology has been conducted. A major premise of the DIAS technology development is that a large part of the high-latitude portion of this research has gone unused, largely because it does not lend itself to straightforward deterministic modeling. With the advent of knowledge-based expert systems, the more qualitative or subjective material can now be effectively utilized. The objective of this task is to review this research in order to locate data useful to the DIAS development. In addition, other tasks enable several of the few remaining experts in the field to verify and enhance this information.

2.1 SOURCES

The literature search included five sources. These were

1. NOSC Technical Library
2. Naval Postgraduate School Technical Library
3. Personal Library of R.B.Rose (NRaD)
4. Personal Library of Dr. Adolf Paul (NRaD)
5. Personal Library of Dr. Robert Hunsucker (U of Alaska)

The literature search included both Journal Publications and Technical Reports. The following journals provided articles published between 1965 and the present:

a. Radio Science
b. Journal of Geophysical Research
c. Journal of Atmospheric and Terrestrial Physics
d. Planetary and Space Physics
e. Proceedings of the Ionospheric Effects Symposium, 1981, 1984, 1987

Primary sources for Technical Reports were the Naval Ocean System Center La Posta Astrogeophysical Observatory (closed 1978), the Air Force Cambridge Research Laboratory (now AFGL), the Naval Research Laboratory, and the National Solar Observatory at Sacramento Peak.

This literature is listed in the reference bibliography (Section 5), which will be updated throughout the DIAS developmental period.

3.0 MISSION

3.1 MISSION REQUIREMENTS

In assessing the reliability of HF communications, a key factor is being able to accurately predict electromagnetic-propagation conditions. This is especially true for predicting HF connectivity for the many varied combinations of environment and path configurations that can exist at high latitudes. The prediction tool must consider the propagation environment and all associated parameters. These parameters include power, attenuation, polarization, transit time, angle of arrival (vertical and azimuthal), and waveform distortion factors. Although the disturbance phenomena do not lend themselves to accurate algorithmic solutions, predictions must still be reasonably accurate and reliable. The prediction tool must be quick and easy to learn and use. And, finally, it must support both research and operational users.

By far the most complex signal environment in which to operate is at high latitudes above 50 degrees north. The medium that supports propagation of HF signals is magnetically and chemically complicated and often described as turbulent. High-latitude phenomenology does not lend itself to simple closed-form equations that describe the propagational physics. Consequently, development of past signal-assessment systems has avoided dealing with the problem. However, employment of expert-system technology in the DIAS development exploits the use of subjective or qualitative information to infer disruptive conditions. Merging this technology with traditional algorithmic PROPHET HF propagation technology now provides an advisory warning system that activates when the operational mission is in jeopardy.

3.1.1 EXPERT SYSTEMS DEFINED

An expert system is a program that relies on a body of knowledge to perform a difficult task usually performed by a human expert. An expert system successfully deals with problems for which clear algorithmic solutions do not exist. It derives its principal power from the knowledge the system embodies rather than from search algorithms and specific reasoning methods. The expert system's knowledge may exist in a variety of forms, including "rules" and "objects." It also may be in the form of conventional formats such as text, tables, and algorithmic routines. This variety provides a closer equivalence to knowledge as domain experts use it.

From an architectural point of view, most early expert systems

a. dealt with a focused task having a rather narrow range of utility.

b. explicitly separated the knowledge from the reasoning method employed to draw conclusions based on that knowledge.

c. could explain their own actions and lines of reasoning.

Two major lessons contributed to the success of expert-system technology. First, the following became obvious: the limitations of general-purpose reasoning and the criticality of explicit knowledge in problem solving and reasoning. Since the use of highly specific domain knowledge led to successful reasoning, it was useful for problems that have a narrow focus.

Second, success in solving several sharply constrained real-world problems clearly demonstrated that simple knowledge representation was a useful tool. When this was coupled with straightforward reasoning techniques in a hybrid design, more abstract or vague scientific problems could be solved. Thus, the complexity of describing the high-latitude environment was one of the key factors that indicated DIAS should adopt a hybrid approach.

3.2 PRIMARY MISSION

DIAS is a high-latitude ionospheric propagation system designed to assist users of transauroral and transpolar HF circuits. It supports the maintenance of circuit continuity during periods of solar-induced, near-earth ionospheric disturbances. DIAS provides alphanumeric information in plain text format that consists of

1. **ALERTS**, which inform the user that a solar-terrestrial event has occurred.

2. **ADVISORIES**, which indicate the likelihood that a signal disruption (or enhancement) will occur.

3. **MISSION IMPACT STATEMENTS**, which give the expected magnitude and duration of degraded signal conditions as a function of time.

3.3 SECONDARY MISSION

The secondary mission of DIAS is to enable the operational user to query the system for additional information. These queries will allow the user to determine (1) why a particular response appeared and (2) the geophysical nature of the expected disturbance. In addition, the architecture allows the user to obtain details of various parameter values.

3.4 OPERATIONAL ENVIRONMENT

DIAS supports HF-propagation analysis and forecasting in the disturbed physical environment at high latitudes. As a software system operating as a stand-alone function in the Medusa system, its operational environment consists of:

a. A Digital Equipment Corporation computer system or work station running the VMS operating system;

b. Medusa host and interface software;

c. DIAS system operational software;

d. A CA-DISSPLA graphics software system;

e. An environmental datalink from the GOES weather satellite;

f. First-Class Expert System Runtime (and Development) Software.

3.5 SUPPORT ENVIRONMENT

The DIAS support environment is functionally equivalent to the operational environment.

3.6 SAMPLE TEST FILES

The following sample input (.in) files (designed to trigger the various FCDIAS disturbance modules) are provided as a benchmark to help verify correct operation of FCDIAS. The results that should be obtained with FCDIAS, Version 2.0, are given in the corresponding output (.adv, .why, and .out) files.

Sample Input File	Disturbance Modules Triggered
nodist01.in	(none)
sid0i.in	SID.kbm
sid02.in	SID.kbm
pca01.in	PCA.kbm
pca02.in	PCA.kbm
pcanow01.in	PCANow.kbm
is01.in	IS.kbm
azaaur01.in	AZA.kbm, Aur.kbm
pcaaur01.in	PCA.kbm, Aur.kbm
pcaaur02.in	PCA.kbm, Aur.kbm
sidaur01.in	SID.kbm, Aur.kbm
multi01.in	SID.kbm, PCA.kbm, Aur.kbm
multi02.in	IS.kbm, AZA.kbm, Aur.kbm

4.0 DIAS ARCHITECTURE AND FUNCTIONS

4.1 SYSTEM ARCHITECTURE

The DIAS software system (figure 1a) is a tenant subsystem of the Medusa system. Its operations are transparent to the operator - and its host, Medusa, supports operator I/O, realtime environmental data input, and operation of both conventional and expert-system application modules. Environmental input requirements are provided by GOES weather satellite data, as described in Appendix A. Note that with the modular architecture of DIAS, to use a different data source requires only that the GOES earth receiving station and the data-stream interpreter modules be modified.

DIAS consists of three main parts:

1. The **DIAS interface.** This interface interacts with Medusa, the operator, the environmental data inputs, the algorithmic applications modules, and the DIAS expert-system application.

2. **Algorithmic modules** that specify the scenario and quantitative effects of disturbances on HF paths.

3. The **DIAS expert system** that contains **knowledgebase** or **ruleset modules** that infer the liklihood, impact, and other qualitative effects of the disturbances.

4.1.1 DIAS INTERFACE

The **DIAS interface** (figure 2) is an interactive module that provides for all DIAS-related communications among Medusa, the operator, the environmental data inputs, the algorithmic applications modules, and the DIAS expert-system application. The interface is activated by the Medusa executive when an operator selects **DA** (Disturbance Assessment). The interface, using a scenario provided by Medusa, sets values for known parameters, monitors the geophysical environmental input data, displays the interface screen, and runs algorithmic applications modules. The interface screen allows the operator to enter or modify parameters, to invoke realtime environmental data inputs, to instruct Medusa to run the DIAS expert system, and to view the DIAS advisory and explanation output files.

4.1.2 ALGORITHMIC APPLICATIONS MODULES

The algorithmic applications modules are conventional programs or subroutines that calculate and generate data inputs required by the DIAS interface. They address deterministic problems for which conventional algorithmic methods apply.

4.1.3 DIAS EXPERT SYSTEM

The DIAS expert system employs rules (in an equivalent decision-tree form) in determining the likelihood, probable impact, and other characteristics of the various ionospheric disturbances. It then writes out its conclusions in plain-text advice and explanation files.

DIAS assesses each type of high-latitude disturbance with an expert-system module comprised of one or more FCDIAS decision-tree rulesets (detailed in Appendix B) that are equivalent to the VPDIAS rulesets. They have been constructed from graphical charts, expert observations, or other qualitative information that did not lend itself to solution by traditional deterministic means. They not only contain information that will determine whether to invoke a particular module, but also internal explanatory information about why the system needed a particular parameter. Thus, users can query to various levels of detail depending upon their information requirements. Throughout the remainder of this document, the .kbm suffix indicates knowledgebase or ruleset modules, in contrast to the conventional algorithmic application modules.

4.2 SYSTEM FUNCTIONS

The flow diagrams of figures 1a and 1b give an overview of how DIAS functions. They show the present (30 Sep 92) and planned (future) functional relationships among the various DIAS modules, including how the application tasks are interconnected. The DIAS system consists of three functional areas that correspond to its three main architectural parts: (1) **parameter maintenance**, (2) **application tasks**, and (3) **expert-system tasks**. The system runs in realtime. A date-time clock provides two constantly changing parameters, the time of day and the day of the year, that account for day/night and seasonal dependencies in the propagation models.

Concurrently, DIAS monitors the data stream from solar sensors on the GOES weather satellites. A satellite downlink to a **GOES earth station** provides a continuous data stream. The DIAS **event detector** module monitors the X-ray data in this stream. When it senses the occurrence of a solar flare, the flare's onset starts a 120-hour event clock. Then, at various time intervals, as initiated by the user (currently) or automatically (in the future), the DIAS expert system determines the likelihood of each type of ionospheric disturbance based on the time that has passed since the flare. For each likely disturbance, it then infers the expected impact based on measured increases of solar X-rays and high- and low-energy particles. The outputs from these expert-system modules provide estimates of signal loss on the specific HF circuit of interest. As the final step, the system formats the information into an advisory for the Medusa user. Then, in the future, the system

Disturbance Impact Assessment System (DIAS)
Version 2.0 September 1992

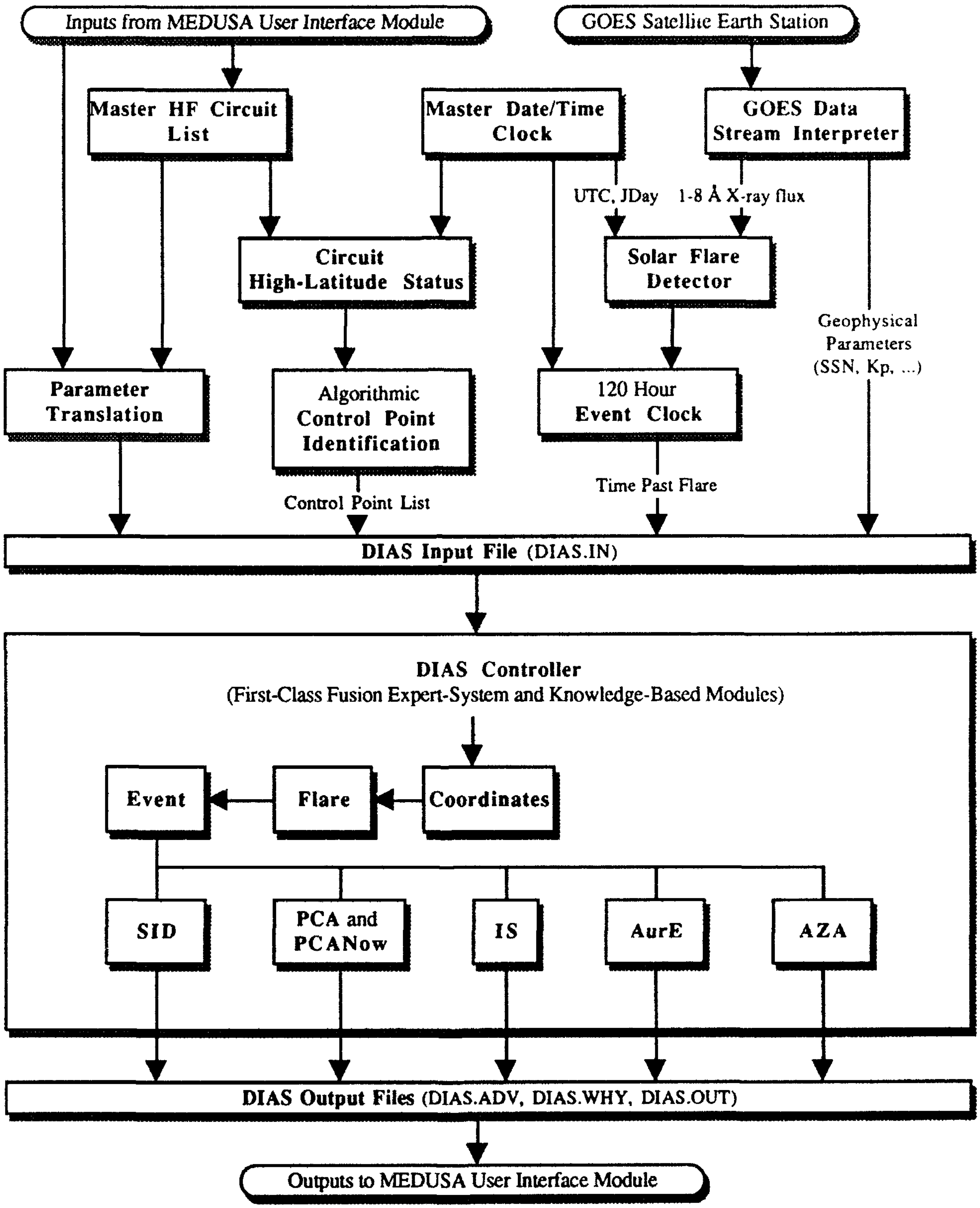

Figure 1a. DIAS Functional Flow Diagram (end of FY 92).

Disturbance Impact Assessment System (DIAS)
Future Version, Proposed September 1992

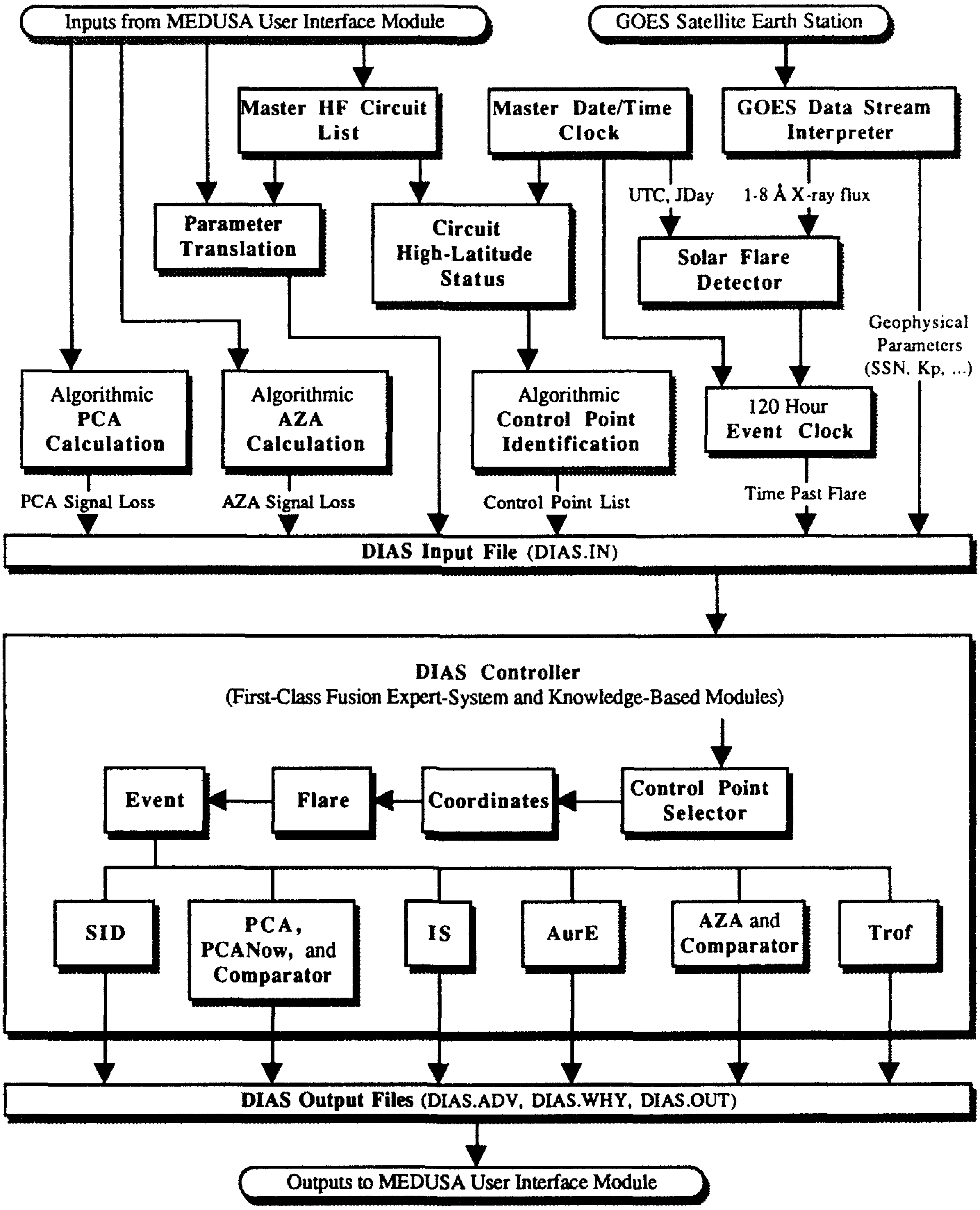

Figure 1b. DIAS Functional Flow Diagram (proposed as of September 92).

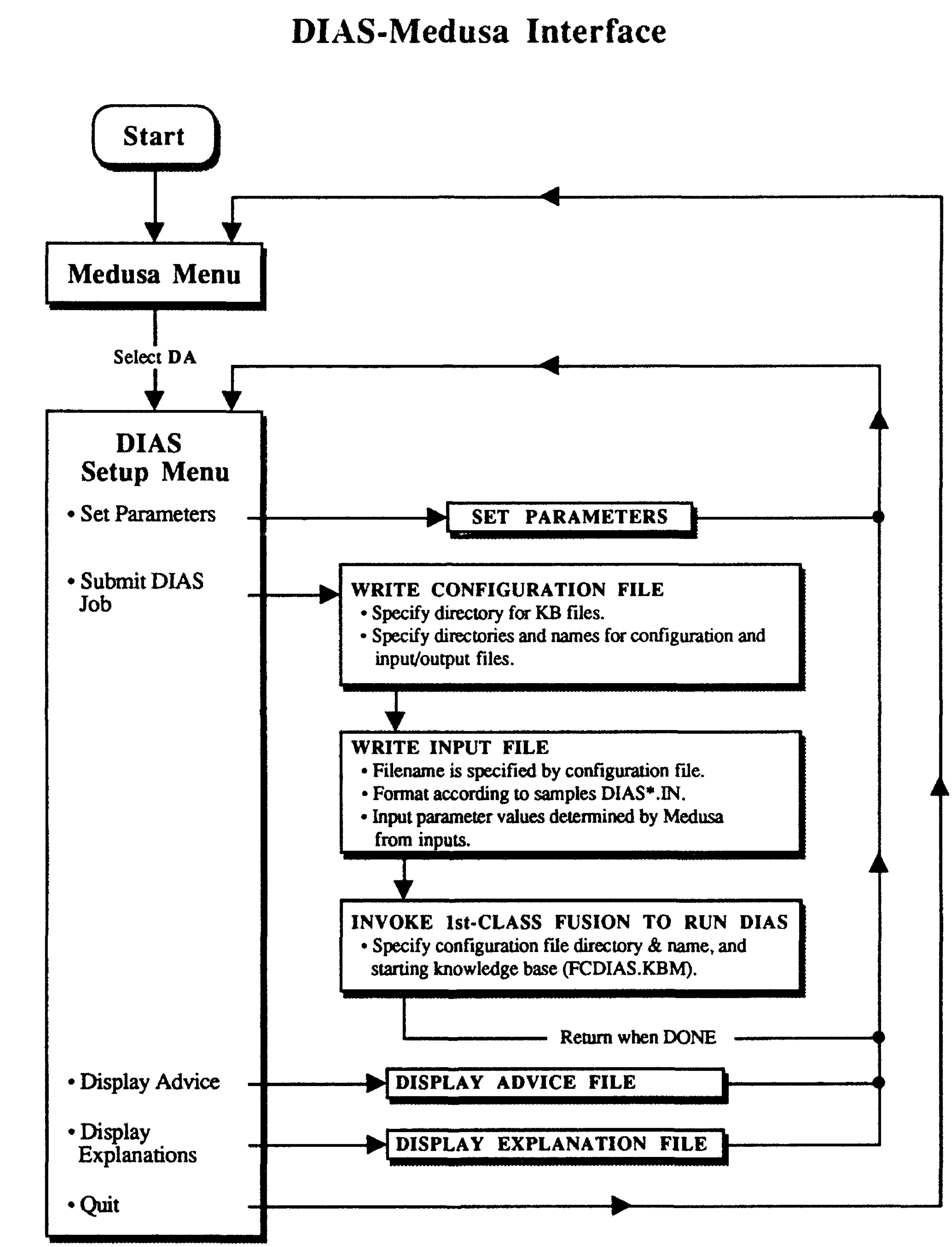

Figure 2. Disturbance Assessment (DA) Interface for setting up and running DIAS from Medusa.

would use this information to update the signal loss data in the raytrace analysis for each HF path.

4.2.1 PARAMETER MAINTENANCE

The propagation environment is changing constantly as a function of time of day and season. This creates a situation in which the given HF circuit's ionospheric control points are constantly changing. In the future, a parameter maintenance function will update the geometrical configuration of the control points, and an algorithmic model will generate a median ionospheric profile for the final raytrace analysis.

4.2.2 APPLICATION TASKS

Application tasks perform a number of functions. They produce the parameter values that drive the parameter-maintenance function and specify the geographical locations of key parameters, including the ionospheric control points for the auroral oval. They perform refractive analysis on HF signals and also determine signal loss and signal-to-noise ratios on high-latitude circuits. The application tasks in DIAS are

a. Flare Event Detection.
b. Date and Time Maintenance.
c. Environmental Data Stream Interpretation.
d. Median Ionosphere Generation.
e. Propagation Control Point Conversion.
f. Signal Refractive Analysis (Raytrace).
g. High-Latitude Signal Status Assessment.
h. Signal Loss (or Enhancement) Assessment.

Section 4.3 presents detailed information about these modules.

4.2.3 EXPERT-SYSTEM TASKS

The DIAS expert-system tasks predict the likely impact of ionospheric disruptions based on changes in geophysical measurements. Inputs include measurements of solar X-ray flux, high-energy protons, low-energy particles, and the earth's magnetic field. Outputs include the likelihood, duration, and impact of the following disturbances:

a. a sudden ionospheric disturbance (SID).
b. a polar-cap absorption event (PCA).
c. an ionospheric storm (IS).
d. auroral E (Aur).
e. auroral zone absorption (AZA).

The functional flow of the expert-system tasks and how general control is exercised are shown in figure 1a. The polling order of the expert-system modules is shown in figure 3.

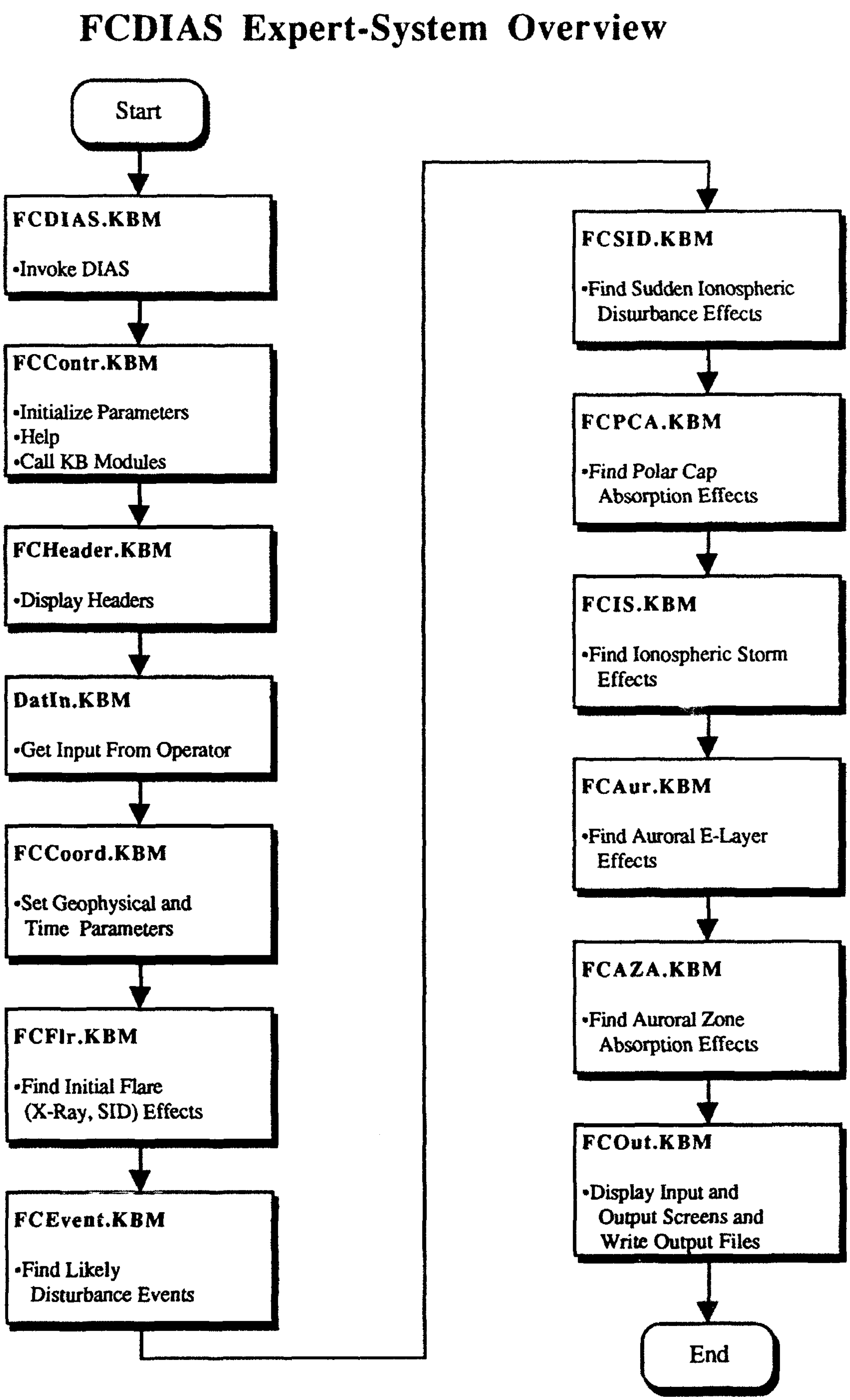

Figure 3. Overview of FCDIAS Expert-System modules.

4.3 ALGORITHMIC AND EXPERT-SYSTEM MODULES

The following paragraphs provide functional and parametric descriptions of each block shown in figure 1a. The following information is given for each module:

<u>Part 1.</u>

(1) Developers.
(2) Date Created.
(3) Function.
(4) Called by Subroutine, Function, or Knowledgebase.
(5) Parameters Passed (Inputs).
(6) Parameters Returned (Outputs).
(7) Common Block Returned.
(8) Functions, Subroutines, and Knowledgebases Referenced.
(9) References.
(10) Change History.

<u>Part 2.</u>

Logic Flow Diagrams based on the .kbm Decision-Tree Rulesets.

Note 1: Figure numbers have been assigned to figures 1a, 1b, 2, and 3 - the system-level descriptions. Individual diagrams of the system modules are referenced and presented under the specific section numbers of the paragraphs that describe them.

Note 2: Pages left intentionally blank have been done so because the diagrams are not available.

4.3.1 MASTER DATE/TIME CLOCK MODULE

4.3.1.1 Module Description (algorithmic)

(1) Developers - B. J. Satterlee. Edit - D.R. Lambert.

(2) Date Created - Existing Module.

(3) Function - The purpose of the Date/Time Clock is to provide the current time (UTC) and Julian day of the year. These data are needed for the models that have diurnal and/or seasonal dependencies. This function usually resides internally in most computer systems and can be accessed through standard operating system calls.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - None.

(6) Parameters Returned (Outputs) - UTC Time (Hours, minutes, seconds), and Julian Day (1-365).

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - None.

(9) References - None.

(10) Change History - VAX conversion 30 September 1990.

4.3.1.2 - Master Date/Time Clock Flow Diagram

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4.3.2 GOES EARTH RECEIVING STATION

4.3.2.1 Module Description (Self-contained capability)

(1) <u>Developer</u> - Equatorial Communications Co.

(2) <u>Date Created</u> - 1985 (Approximate).

(3) <u>Function</u> - This module provides a micro satellite-receiving earth station. Data from solar sensors on the GOES weather satellites is monitored in realtime by the NOAA Space Environmental Support Center (SESC), Boulder, CO. This data is transmitted to Equatorial Communications, Mountain View, CA, where the data is sent by an uplink to the SESC satellite broadcast communications satellite. The signal is then transponded on downlinks to earth station users. The realtime data available includes geomagnetic data, solar data, ionospheric data, and special support forecasts and warnings. The variation in the solar parameters drives DIAS.

(4) <u>Called by Subroutine, Function, or Knowledgebase</u> - None.

(5) <u>Parameters Passed (Inputs)</u> - WESTAR IV data downlink.

(6) <u>Parameters Returned (Outputs)</u> - Geomagnetic Data, Solar Data, Ionospheric Data, Forecasts, Warnings, Alerts, Special Support (see reference 2).

(7) <u>Common Block Returned</u> - Global Variables.

(8) <u>Functions and Subroutines Referenced</u> - GOES Data Stream Interpreter.

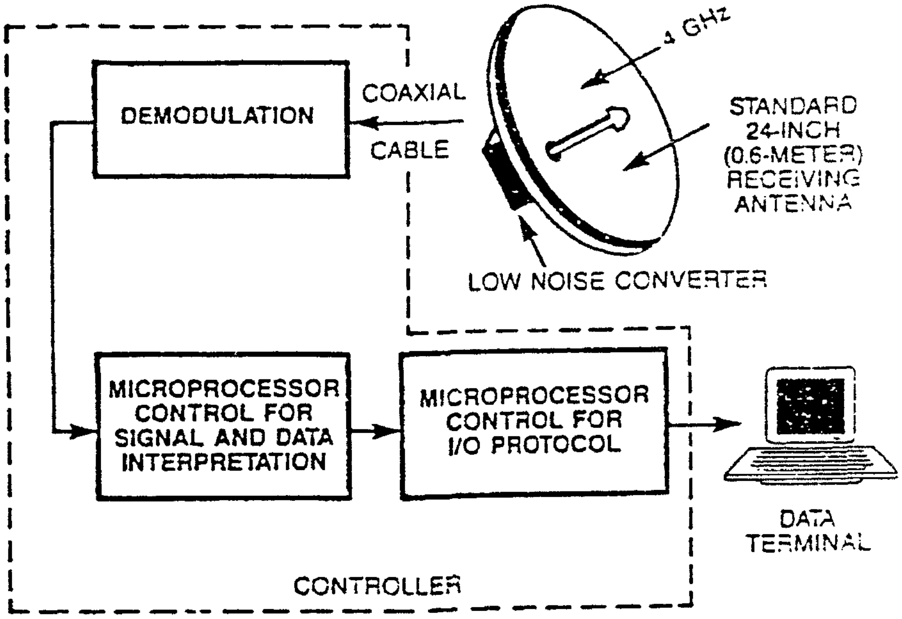
(9) <u>References</u> -

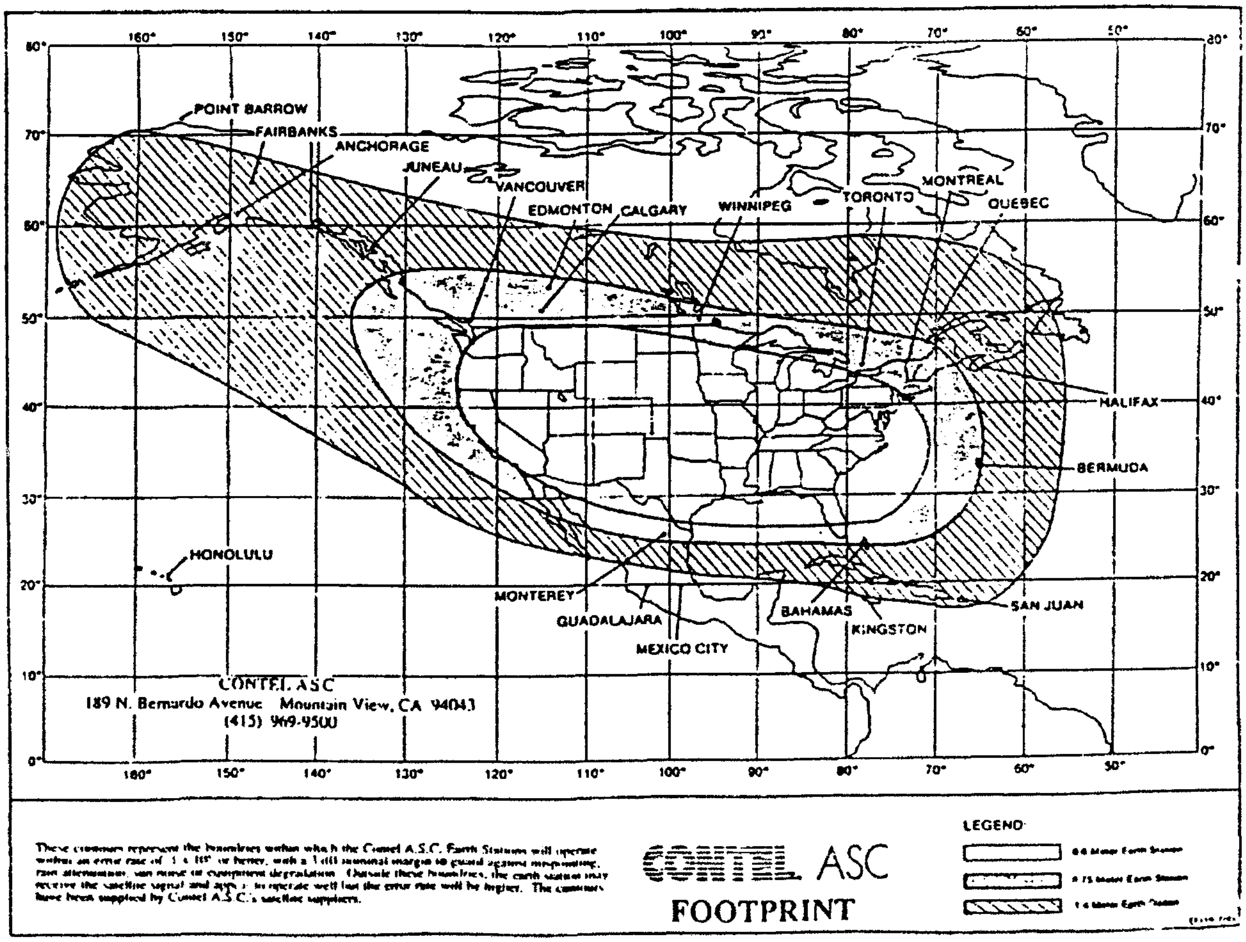
1. Equatorial Communications Co. "**Installation Guide Model C100 Series Micro Receiving Earth Station,**" Document number 03-0002-01D, not dated.

2. NOAA, Space Environmental Support Center. 1983. "**SESC Satellite Broadcasts,**" Newsletter R/R/SE2:KLC, 20 September 1983.

(10) <u>Change History</u> - Not Applicable.

4.3.2.2 **Block Diagram of Earth Receiving Station and Satellite Coverage Footprint**





4.3.3 GOES DATA STREAM INTERPRETER

4.3.3.1 Module Description (Algorithmic)

(1) Developers - B. J. Satterlee.

(2) Date Created - 15 January 1990.

(3) Function - This module reads the continuous data stream from the SESC satellite broadcast downlink, converts the data into a format that DIAS can recognize, builds archives of the data, and passes on the data that ~~is~~ are processed in realtime.

(4) Called by Subroutine, Function, or Knowledgebase - Ionospheric Generator Module, Solar Flare Detector Module.

(5) Parameters Passed (Inputs) - Solar-Geophysical data from WESTAR downlink (see reference 2, Module 4.3.2).

(6) Parameters Returned (Outputs) - Solar-Geophysical data in DIAS format.

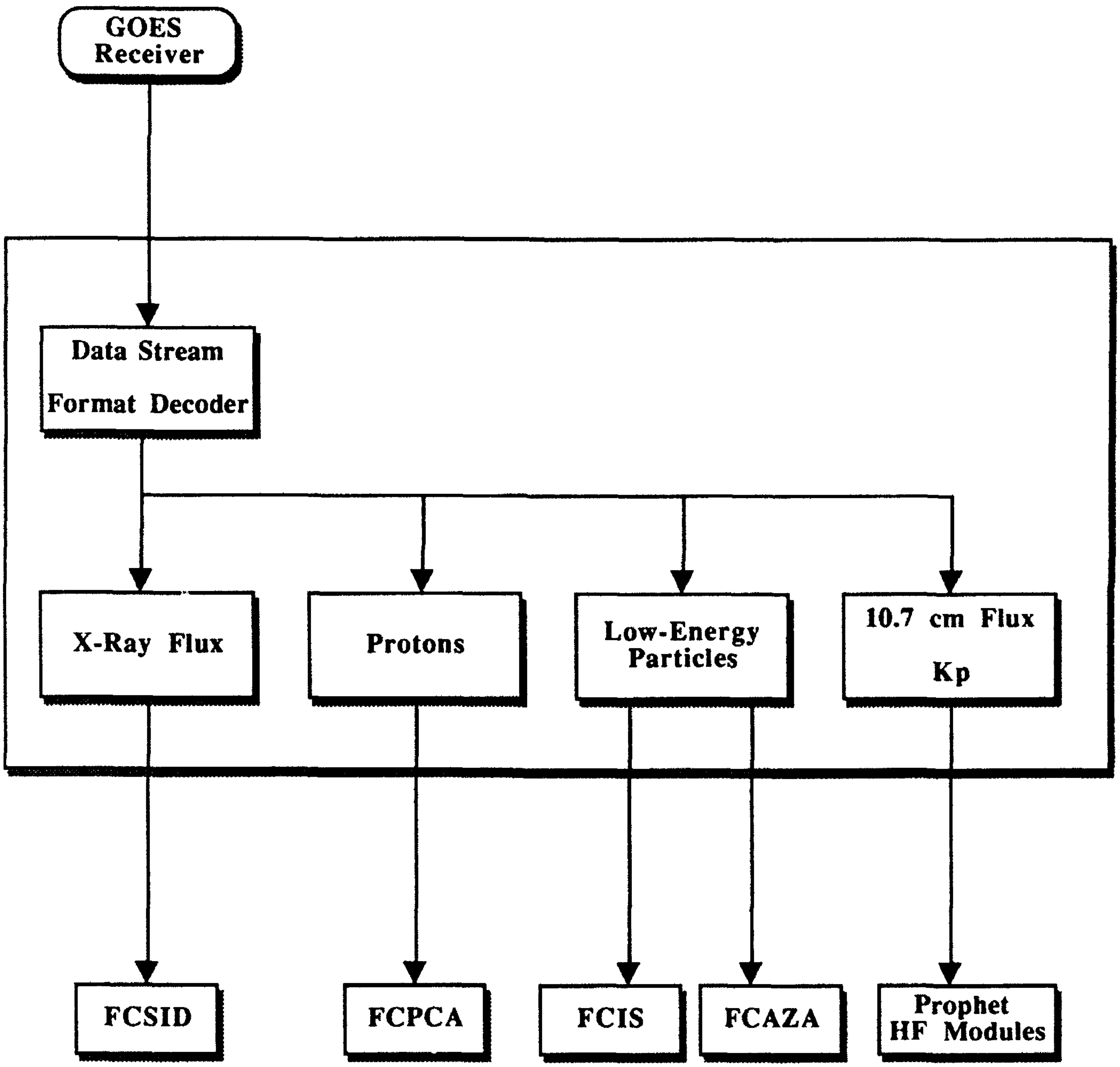
(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Referenced -

(9) References - (See reference 2, Module 4.3.2.)

(10) Change History - VAX conversion 30 September 1990.

4.3.3.2. GOES Data Stream Interpreter Flow Diagram



4.3.4 HF MASTER CIRCUIT LIST MODULE

4.3.4.1 Module Description (algorithmic database management system (DBMS))

(1) Developers - J.N. Martin. Edit - D.R. Lambert.

(2) Date Created - 15 September 1987.

(3) Function - The purpose of this module is to allow the user to create and store all the relevant parameters that define the HF circuit transmit, receive, and jammer nodes. Once created, this DBMS requires only the specification of the end point nodes to create the global scenario geometry.

(4) Called by Subroutine, Function, or Knowledgebase - Specification of HF circuit nodes.

(5) Parameters Passed (Inputs) - Transmitter ID, Receiver ID, Jammer ID.

(6) Parameters Returned (Outputs) - For the transmitter, receiver, and jammer, the Master Circuit List Module returns:
- (a) geographical location (Latitude, Longitude)
- (b) power
- (c) antenna type and orientation
- (d) friendly or hostile
- (e) speed and direction, if node is mobile.

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - None.

(9) References - None.

(10) Change History - 30 September 1990.

4.3.4.2 - HF Master Circuit List Flow Diagram

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4.3.5 HF CIRCUIT HIGH-LATITUDE STATUS MODULE

4.3.5.1 Module Description (algorithmic)

(1) Developers - B.J. Satterlee. Edit. D.R.Lambert.

(2) Date Created - 1 March 1990.

(3) Function - The purpose of this module is to determine how much of the specified high-latitude HF circuit is transiting the **auroral oval**, **high-latitude trough**, and **polar cap** regions, and whether high-latitude disturbance knowledgebases apply.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - Date, Time, Solar Flux, Kp, HF circuit end points.

(6) Parameters Returned (Outputs) - Percentage of path in the auroral oval, percentage of path in the polar cap.

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - Oval Model, Trough Model, Master Station List Module, Geophysical Data Stream Interpreter.

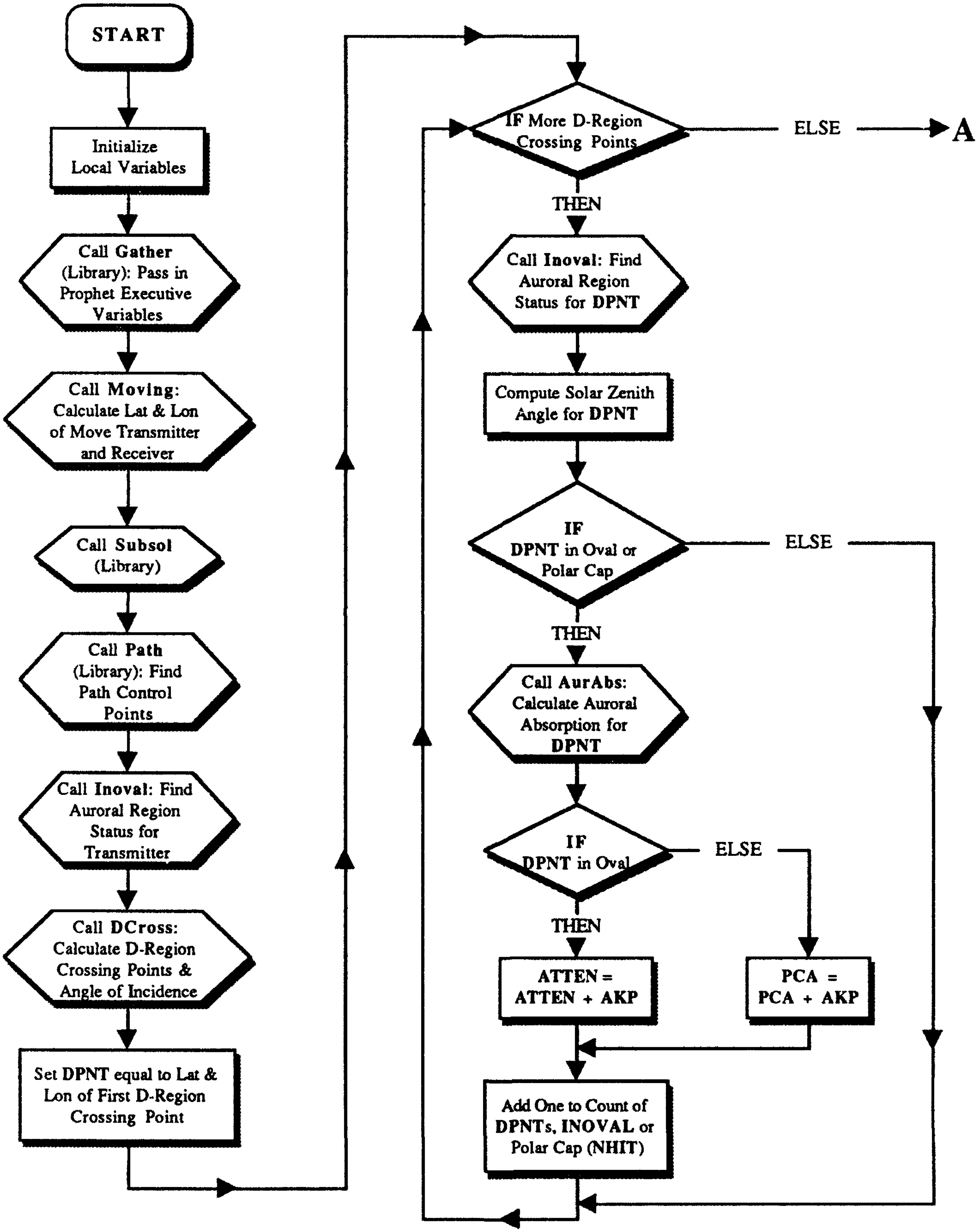
(9) References - None.

(10) Change History - Scheduled for future incorporation.

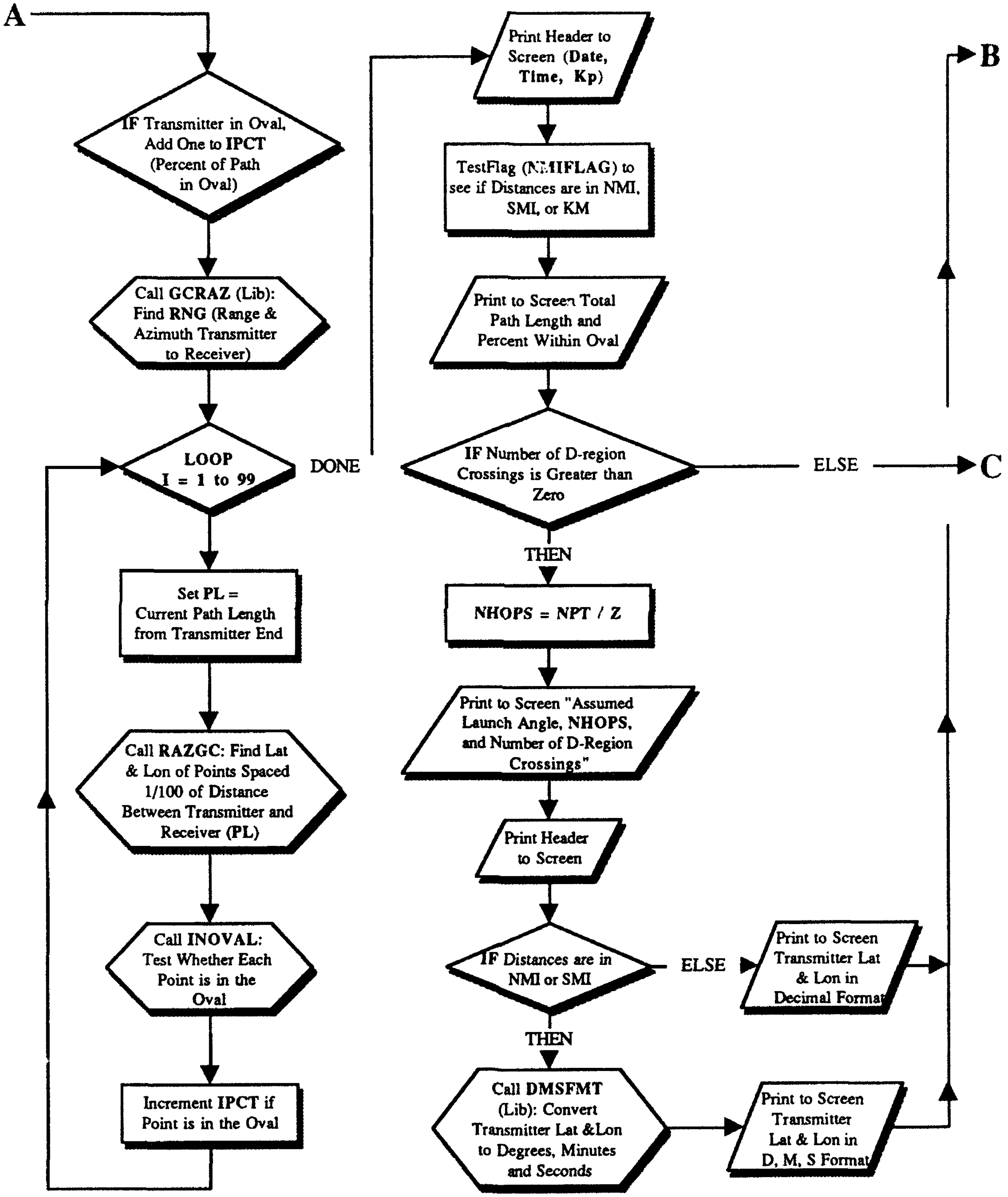
4.3.5.2 - HF Circuits High-Latitude Status Module Flow Diagrams - 8 pages

HF Circuit High Latitude Status Module (page 1)

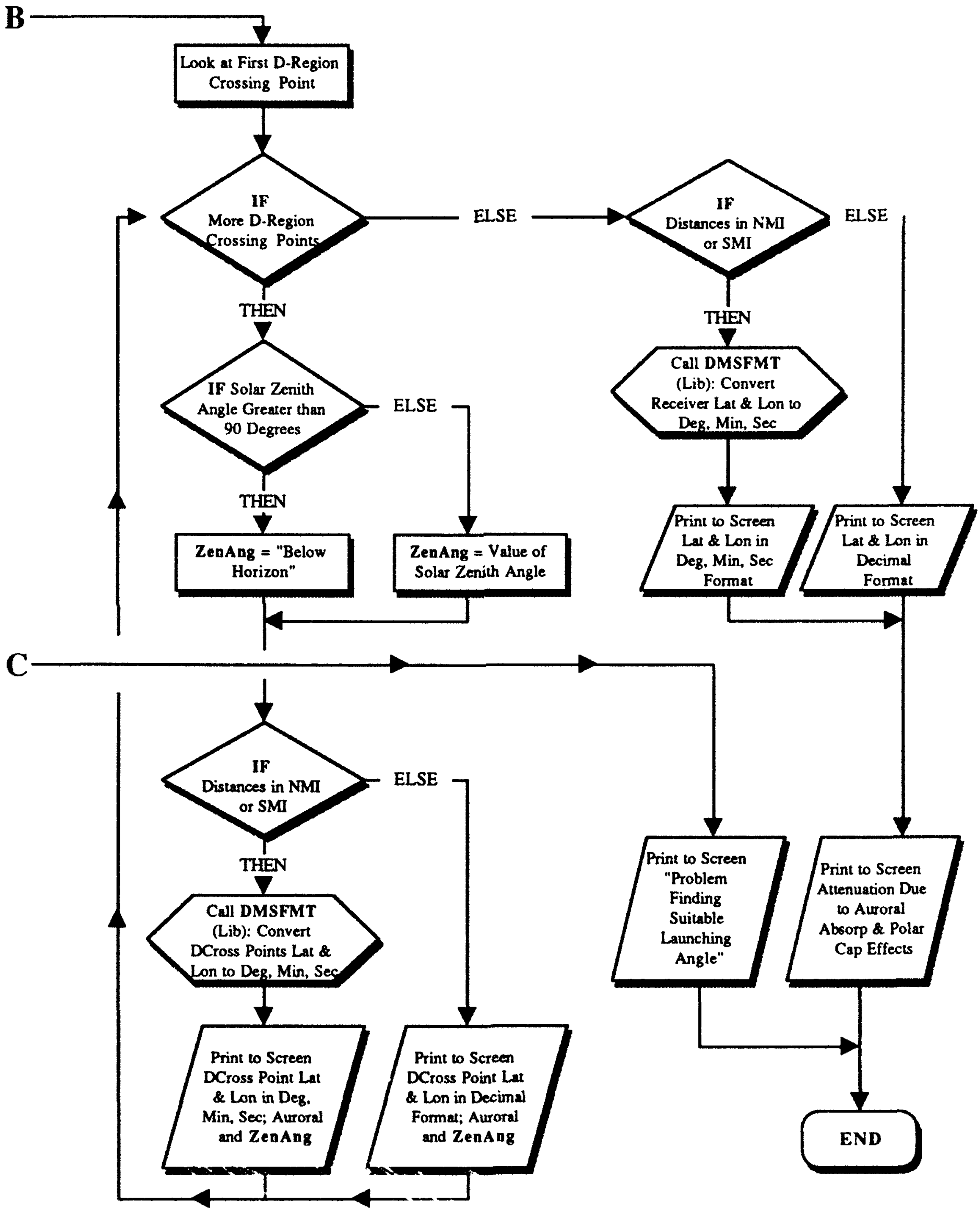
(page 1 of 8)



HF Circuit High Latitude Status Module (page 2)



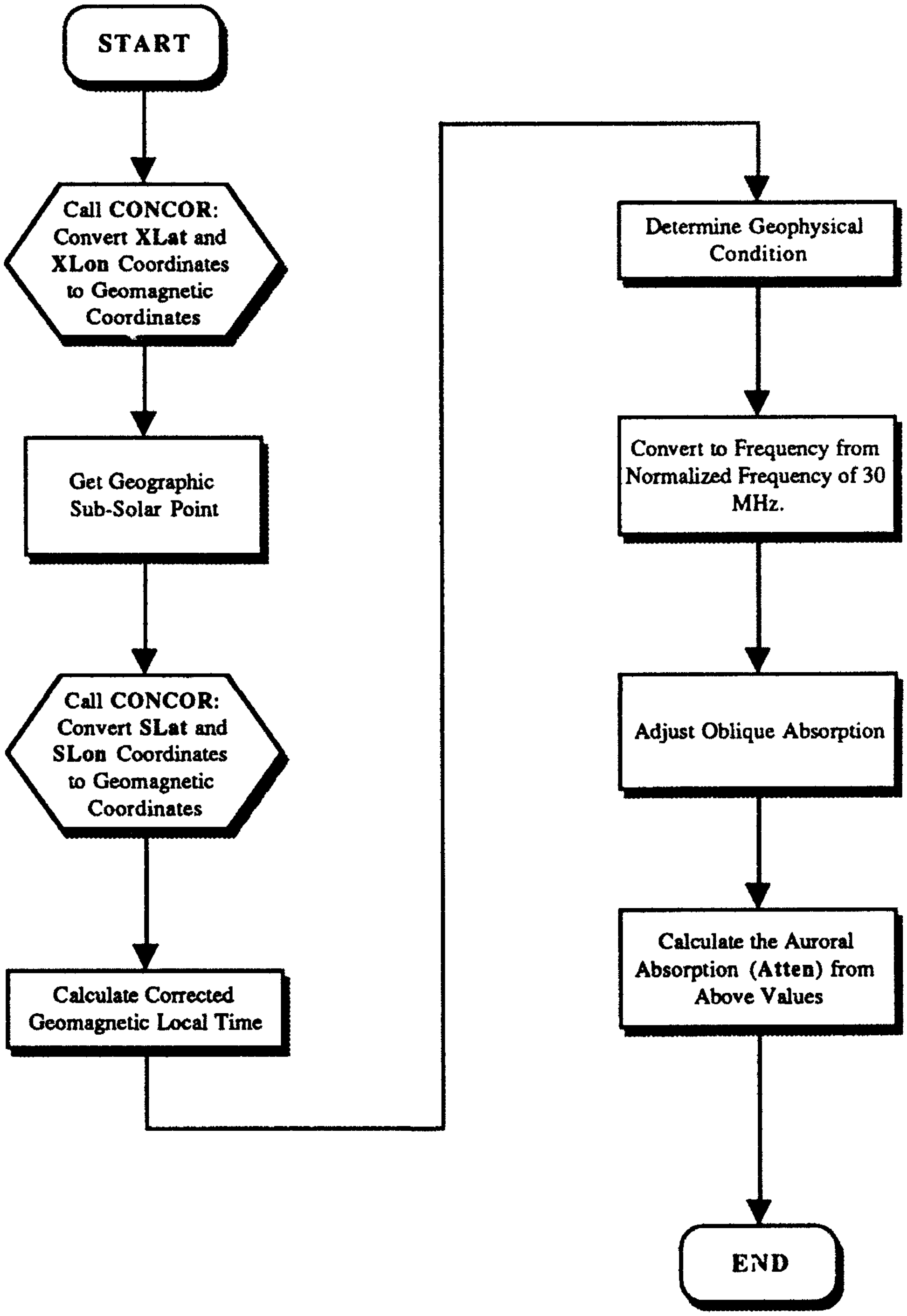
HF Circuit High Latitude Status Module (page 3)



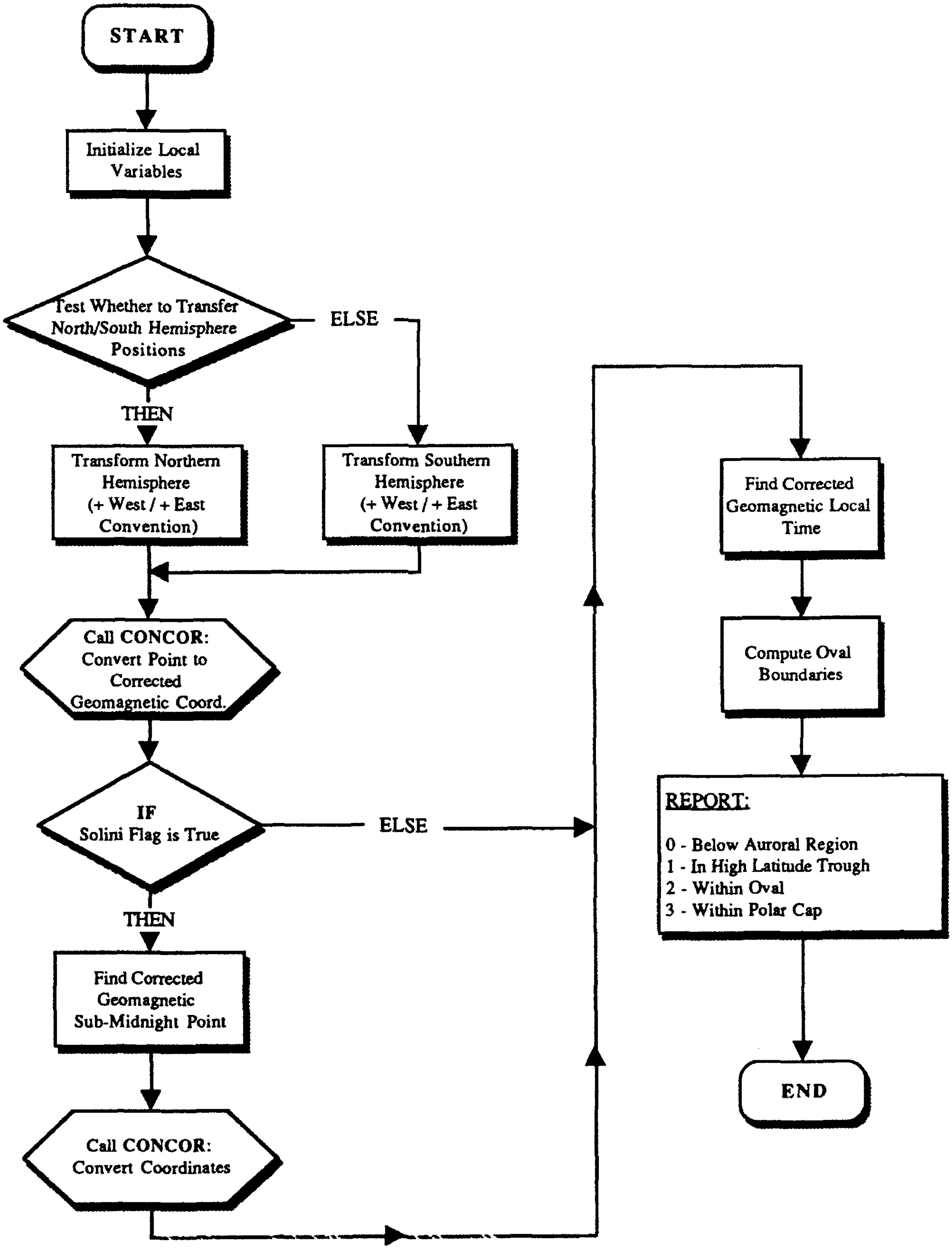
HF Circuit High Latitude Status Module

AurAbs (Subroutine)

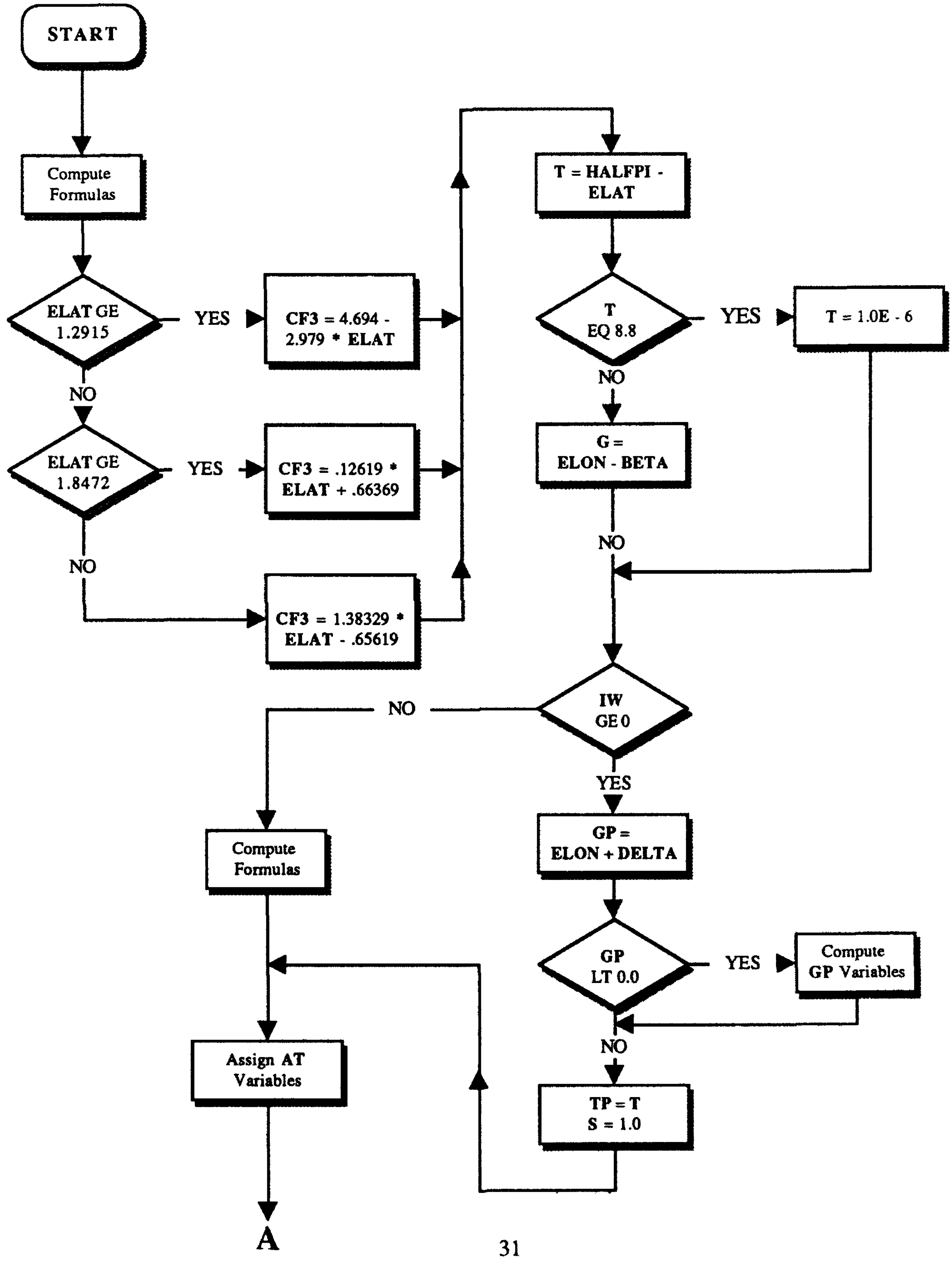
(page 4 of 8)



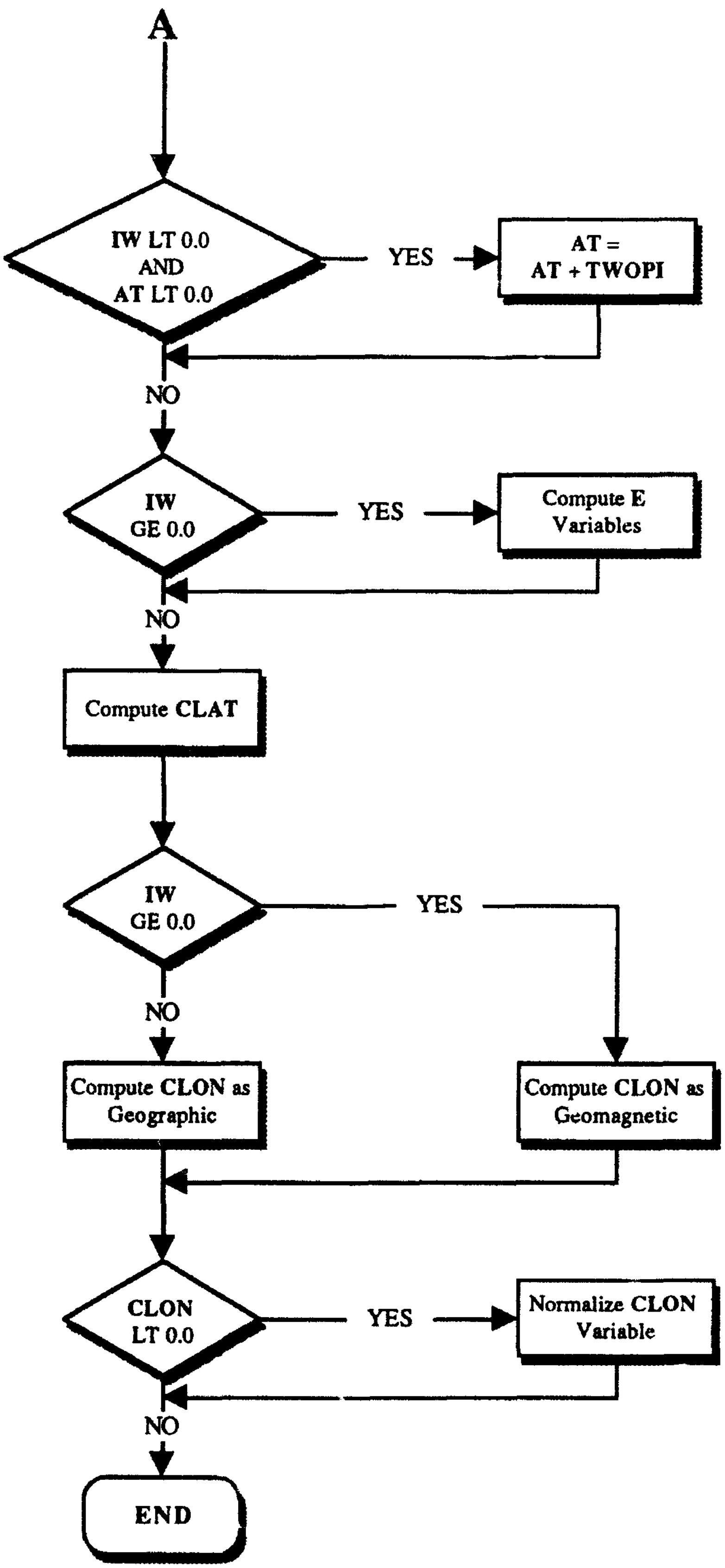
HF Circuit High Latitude Status Module
INOVAL (Subroutine)



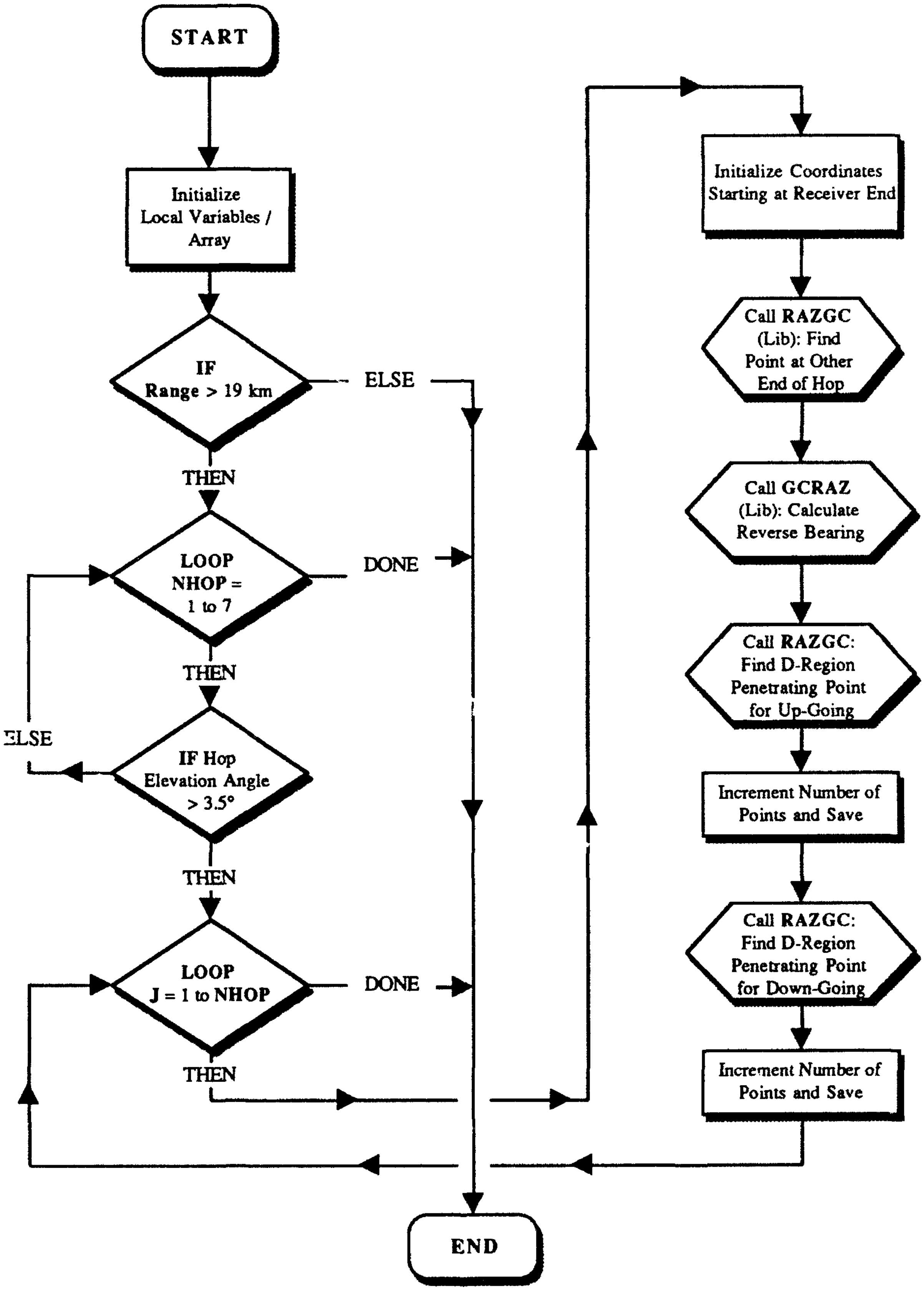
HF Circuit High Latitude Status Module
CONCOR (Subroutine) (page 1)



HF Circuit High Latitude Status Module
CONCOR (Subroutine) (page 2)



HF Circuit High Latitude Status Module
DCROSS (Subroutine)



4.3.6 HF CONTROL POINT IDENTIFICATION AND LOCATION MODULE

4.3.6.1 Module Description (algorithmic)

(1) Developers - B.J. Satterlee. Edit. D.R. Lambert.

(2) Date Created - 1 June 1990.

(3) Function - The purposes of this module are (1) to determine the most likely modes of propagation and (2) to identify any circuit reflection or passage points which lie in the polar cap, auroral oval, or high-latitude trough. The ionospheric reflection points and passage points (the points where the signal passes through absorbing layers) represent potential circuit control points. These include especially E- and F-region reflection points and D-region passage points.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - Geometry of auroral oval, location of trough, HF circuit geometry.

(6) Parameters Returned (Outputs) - Reflection points in polar cap, reflection point(s) in trough, D-region passage points in auroral zone and polar cap.

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - AZA Loss Module, PCA Loss Module, Trough Loss Module, OVAL, Trough, AZA.kbm, PCA.kbm, AUR.kbm, Es.kbm.

(9) References - None.

(10) Change History - Scheduled for future incorporation.

4.3.6.2 - HF Control Point Identification and Location Module Flow Diagram

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4.3.7 SOLAR FLARE DETECTOR MODULE

4.3.7.1 Module Description (algorithmic)

(1) Developers - R.B.Rose and B.J. Satterlee. Edit - D.R.Lambert.

(2) Date Created - 15 March 1990.

(3) Function - The purpose of this module is to monitor the 1-8 angstrom solar X-ray flux from the solar geophysical data interpreter and to determine whether a Class M or X flare has occurred and, if so, the exact magnitude of the flare.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - 1-8 angstrom X-ray flux.

(6) Parameters Returned (Output) - Flare start command; flare magnitude.

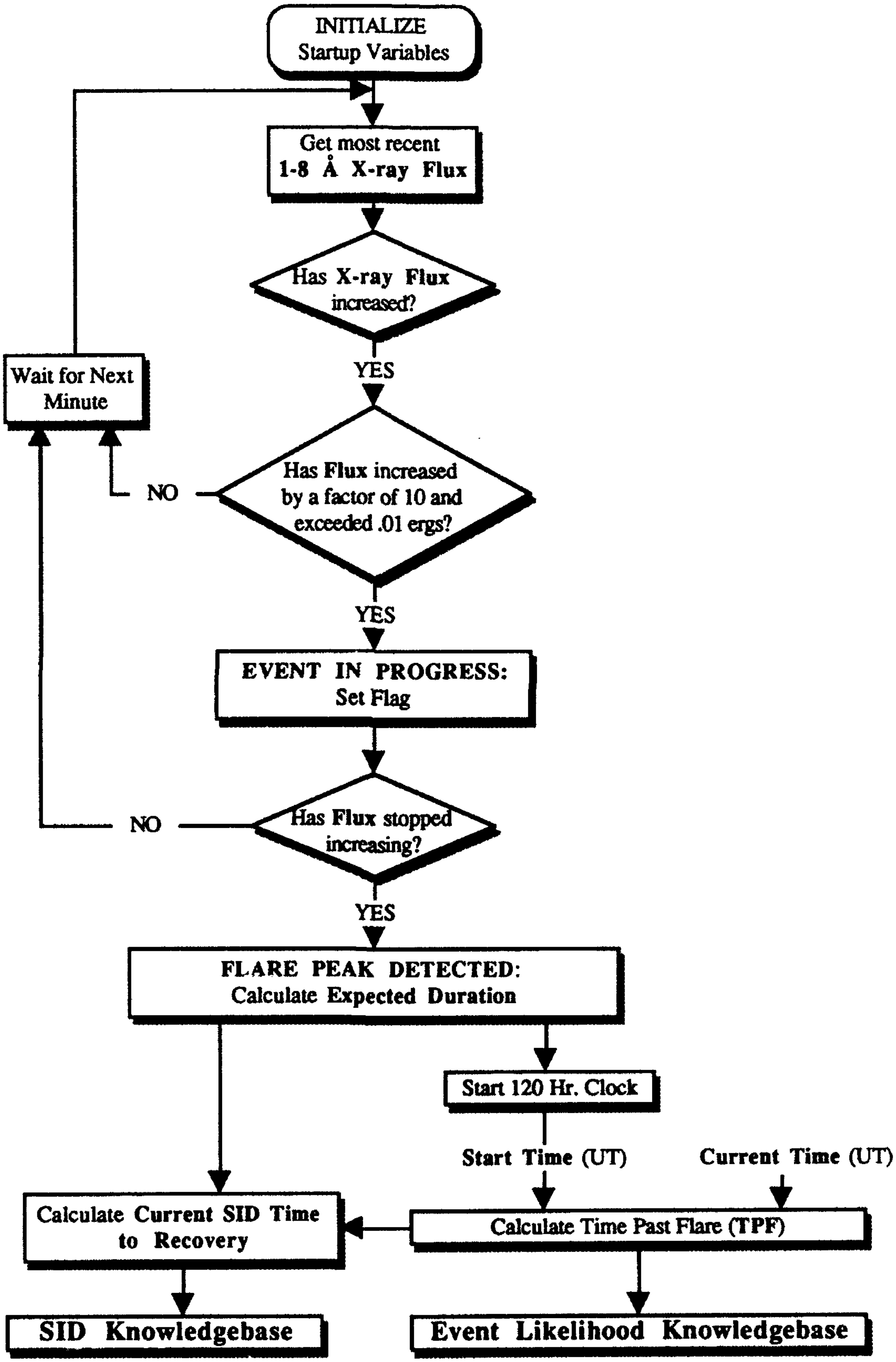
(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - FCSID.kbm, 120-Hour Event Clock.

(9) References - None.

(10) Change History - VAX Conversion 30 September 1990.

4.3.7.2. Solar Flare Detector Flow Diagram



4.3.8 120-HOUR EVENT CLOCK

4.3.8.1 Module Description (Algorithmic)

(1) Developers - B. Satterlee. Edit and FCL ver - D.R. Lambert.

(2) Date Created - 15 March 1989.

(3) Function - Upon the detection of the onset of a solar flare by the Solar Flare Detector (or "event") Module, the 120-Hour Event Clock starts. This module provides an updated time input to the various modules in DIAS that are time dependent.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Input) - Start of Flare command from Flare Detection module.

(6) Parameters Returned (output) - Current Event Time.

(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Returned - Global Variables.

(9) References - None.

(10) Change History - Original version 15 March 1989.

4.3.8.2 - 120-Hour Event Clock Diagram

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4.3.9 POLAR CAP ABSORPTION LOSS MODULE

4.3.9.1 Module Description (Algorithmic and Knowledgebase Hybrid)

(1) Developers - B.J. Satterlee. Edit - D.R.Lambert.

(2) Date Created - 1 June 1990.

(3) Function - The purpose of the Polar Cap Absorption (PCA) Loss module is to use the ionospheric signal reflection and absorption points (that are derived from the Hi-Latitude Circuit Locator module) and loss data (from the FCPCA.kbm rule set) to modify the signal characteristics in the raytrace analysis. Specifically, additional signal loss is invoked in the raytrace analysis whenever a D-region passage point is identified to be in the polar cap region and certain disturbance criteria apply. The expert system also determines the duration within the 120-hour event period for which this loss is to be applied to the path signal.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - Geographical coordinates within the polar cap, Probability of PCA, Onset Time of PCA, Duration, and Signal Loss (dB).

(6) Parameters Returned (Outputs) - Signal Loss, event onset time and duration.

(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Referenced - FCPCA.kbm, Circuit Hi-Latitude Status Module.

(9) References - None.

(10) Change History - Scheduled for future incorporation.

4.3.9.2 - Polar Cap Absorption Loss Module Diagram

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4.3.10 AURORAL ZONE ABSORPTION LOSS MODULE

4.3.10.1 Module Description

(1) Developers - B.J. Satterlee and W.S. Bratt. Edit - D.R. Lambert.

(2) Date Created - 15 September 1989.

(3) Function - The Auroral Zone Absorption (AZA) Loss module determines (1) whether a circuit's D-region passage points are in the auroral region, (2) whether auroral zone absorption (AZA) is likely, and if so, (3) the amount of absorption, or signal loss, that is incurred by the signal. The AZA is calculated analytically using the Feldstein Auroral Loss Model. It is currently applied in raytrace without discrimination. The DIAS expert system will eventually modify when and how to apply it to the signal path of interest.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - Likelihood of AZA(percent), Absorption (dB), Circuit D-region passage points.

(6) Parameters Returned (Outputs) - Overall absorption of the signal in dB to signal.

(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Referenced - FCAZA.kbm, Circuit Hi-Latitude Status Module.

(9) References -

1. Foppiano, A.J. and P.A. Bradley. 1985. "**Morphology of Background Auroral Absorption**," Journal of Atmospheric and Terrestrial Physics, vol.47, no.7, Pages 663-674, 1985.

(10) Change History - Scheduled for future incorporation.

4.3.10.2 - AZA Loss Module Diagram

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4.3.11 DIAS CONTROLLER (FCContr.kbm)

4.3.11.1 Module Description (DIAS Grand Total: 722 Rules)

(1) Developers - R.B.Rose. Edit and FCL ver - D.R.Lambert.

(2) Date Created - 15 May 1989 (as "ACTIONS" and "CHAIN" commands of various VPX rulesets).

(3) Function - The Controller Module (FCContr.kbm) declares and initializes global parameters, chains to (calls) I/O and flare-effects knowledgebase modules as needed, performs file I/O, and performs operator I/O (not active under Medusa). It is chained to (called) by the DIAS expert-system Startup Module (FCDIAS.kbm, "Set Up and Run Controller"), which may also perform miscellaneous tasks to prepare specific files or other system components for running DIAS.

Figure 4.3.11.1.2 shows the logic flow diagram for the Startup Module, FCDIAS.kbm. Figure 4.3.11.1.3 shows the flow diagram of the Controller Module, FCContr.kbm, which governs activation of the other modules. Figures 4.3.11.1.4 through 6 show logic flow diagrams for the display headers, data entry, and output display modules. Figures 4.3.11.1.11 and 4.3.11.1.12 show a road map which starts at the DIAS Startup Module. The latter figure includes parameter names.

(4) Referenced by - The FCDIAS startup knowledgebase FCDIAS.kbm.

(5) Parameters Passed (Inputs) - All Input parameters. It reads them from the configuration file DIAS.CFG (figure 4.3.11.1.1) and the input file DIAS.IN (figure 4.3.11.1.7).

(6) Parameters Returned (Output) - All Output parameters. It writes them to DIAS.OUT (figure 4.3.11.1.10). All modules collectively write the files DIAS.ADV (figure 4.3.11.1.8) and DIAS.WHY (figure 4.3.11.1.9). If these files already exist, the output is appended to them. No files are deleted.

(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Referenced - FCHeader.kbm, DatIn.kbm via 2DatIn.kbm, FCCoord.kbm, FCFlr.kbm, FCEvent.kbm, FCSID.kbm via 2FCSID.kbm, FCPCA.kbm and FCPCANOW.kbm via 2FCPCA.kbm, FCIS.kbm via 2FCIS.kbm, FCAur.kbm via 2FCAur.kbm, FCAZA.kbm via 2FCAZA.kbm, FCOut.kbm.

(9) References - None.

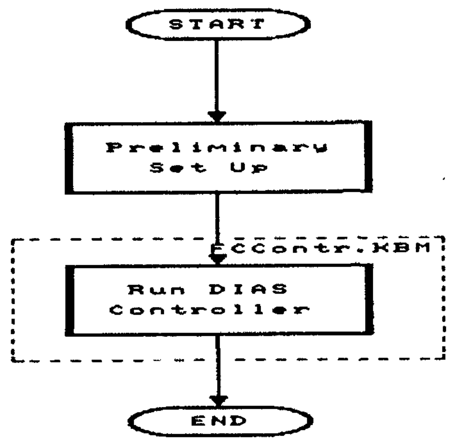
(10) Change History - Original Version 15 May 1989; FC conversion 21 December 1989.

```
IODIR        = DISK$USERDISK:[MEDUSA.DA.IOFILES]
OP_DIGRAPH   = ZZ
FILE_ID      = 17DEC235959
```

Figure 4.3.11.1.1. Sample configuration file DIAS.CFG. These parameter values are used by DIAS to specify the Input/Output (I/O) directory and the I/O filenames: ZZDA17DEC235959.IN, ZZDA17DEC235959.OUT, ZZDA17DEC235959.ADV, and ZZDA17DEC235959.WHY. On the IBM-PC, the filenames will be truncated to the first eight characters plus the three-letter extension.

4.3.11.1.2 - DIAS Startup Module Flow Diagram - 1 page

FCDIAS Module
SET UP AND RUN DIAS CONTROLLER

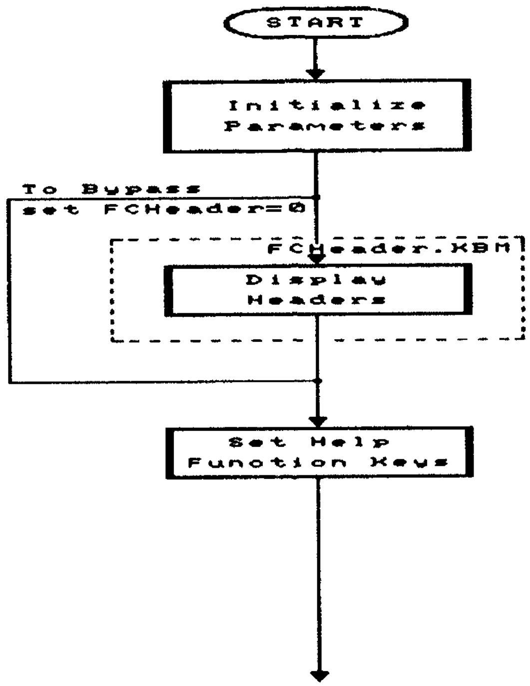


4.3.11.1.3 - DIAS Controller Module Flow Diagram - 7 pages

FCContr Module

CONTROLLER

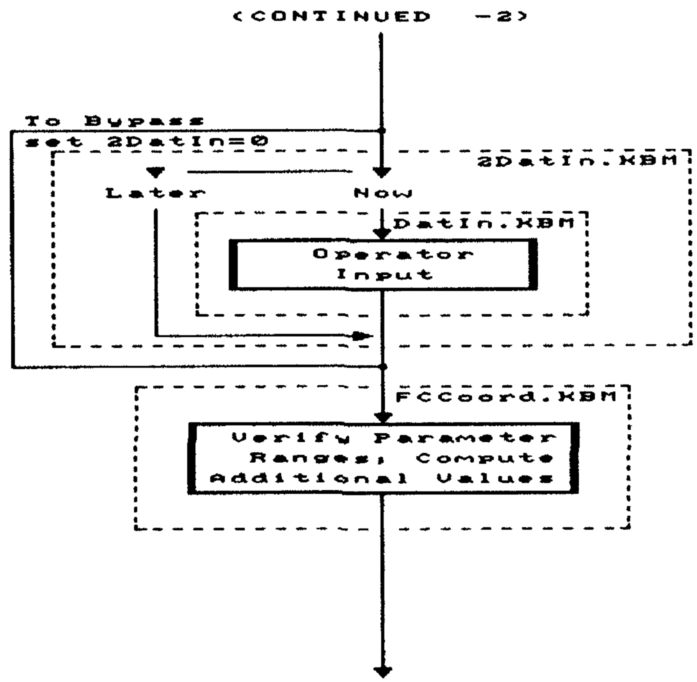
- 1 of 7 -



FCContr Module

CONTROLLER

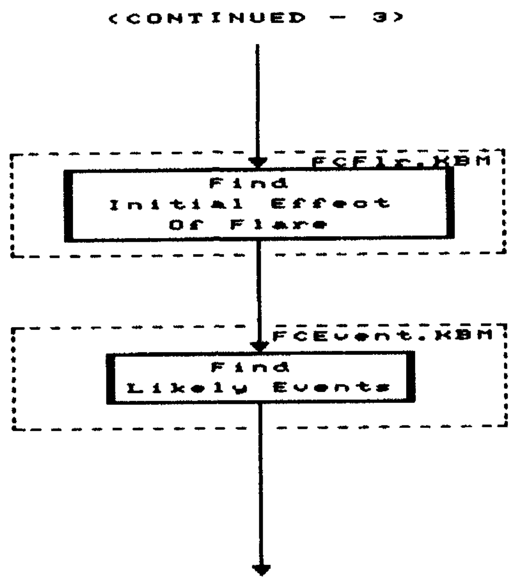
FACTOR:
EnterData



FCContr Module

CONTROLLER

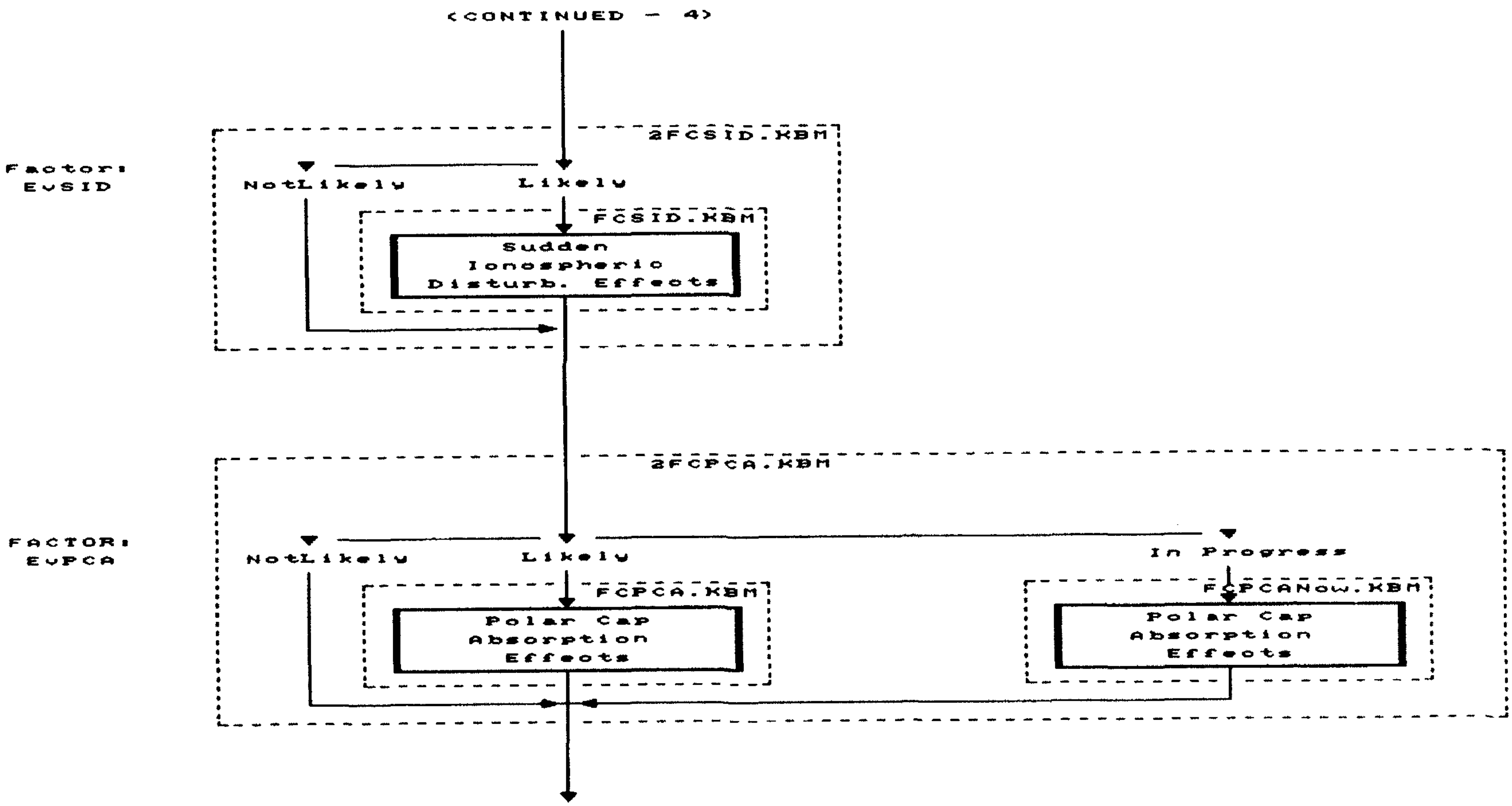
\- 3 of 7 -



FCContr Module

CONTROLLER

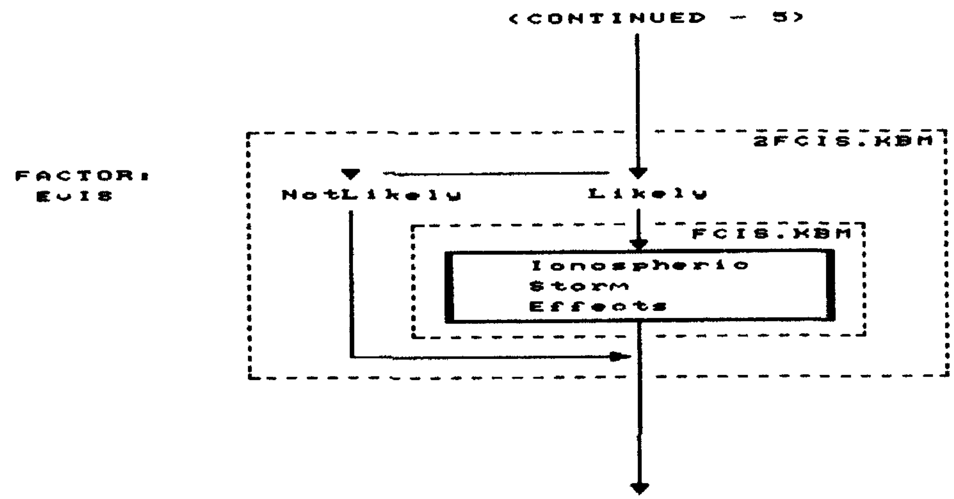
- 4 of 7 -



FCContr Module

CONTROLLER

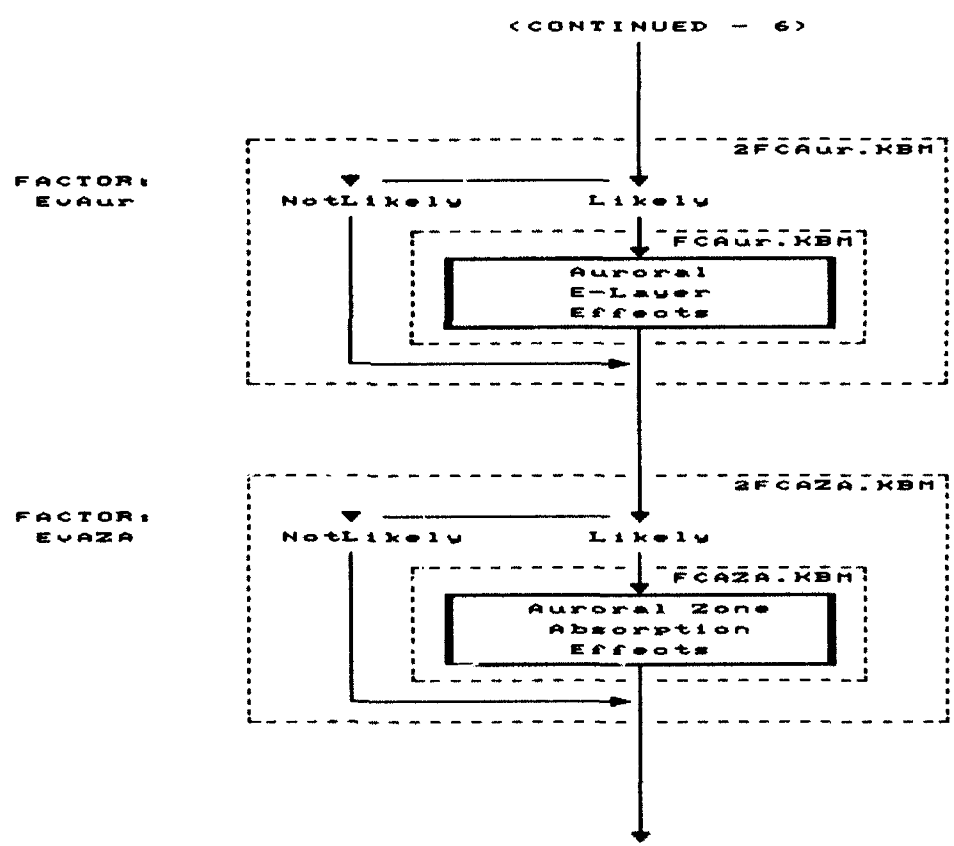
– 5 of 7 –



FCContr MODULE

CONTROLLER

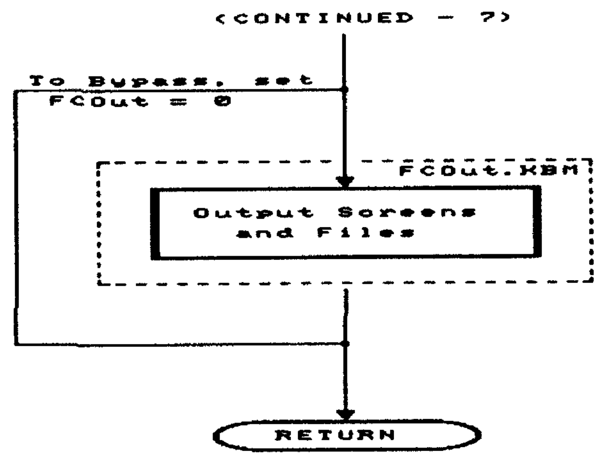
- 6 of 7 -



FCContr MODULE

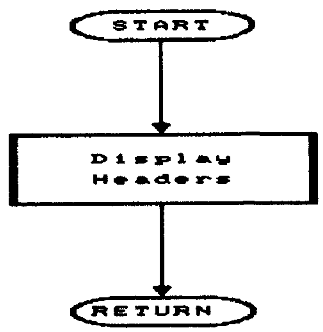
CONTROLLER

- 7 of 7 -



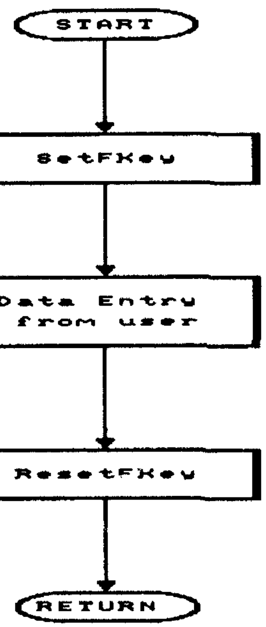
4.3.11.1.4, 5, 6 - DIAS Header, Input, and Output Module Flow Diagrams - 3 pages

FCHeader Module
DISPLAY HEADERS



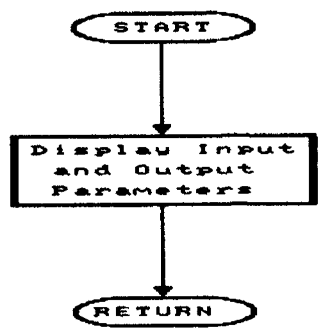
FCDatIn Module

DATA ENTRY FROM USER



FCOut Module

DISPLAY INPUT AND OUTPUT PARAMETERS



4.3.11.1.7, 8, 9, 10 - Sample DIAS Input, Advice, Explanation, and Output Files - 6 pages

```
NEEDFLR      = %
NEEDSID      = %
NEEDPCA      = %
NEEDIS       = %
NEEDAUR      = %
NEEDAZA      = %
DIS          = 2700.
GMLAT        = 67.
GMLON        = 90
GGLAT        = 54.
GGLON        = 92.
MO           = 7.
Yr           = 1992.
HOURUT       = 05.
TODFLR       = Morning
FLRSZINIT    = Very_Large
TPFM         = 110.
PROTONS      = Yes_or_NotK
TENMEVFLUX   = 320.
Kp           = 4.2
APINDEX      = 11.
SSN          = 150.
FOP          = 12.
TODCUR       = Morning
FLRLOC       = 15W
FCHEADER     = 0.
2DATIN       = 0.
```

Figure 4.3.11.1.7. Sample input file DIAS.IN. The configuration file in figure 4.3.11.1.1 specifies that this file (DIAS.IN) actually be named ZZDA17DEC235959.IN.

```
+=====+================+==========+======================================+
| <ZZ><17DEC235959>       DIAS SOLAR FLARE ADVISORY  <Ver  2.00><30 Jun 92> |
| 3_Hr flare of Substantial initial impact, lower 75% HF freqs lost 1st Hr. |
+=====+================+==========+======================================+
|EVENT|IMPACT MAGNITUDE| DURATION |               COMMENTS               |
+-----+----------------+----------+--------------------------------------+
| SID |LUF=      22 mHz| Mins-Hrs |Effects can last minutes to several hrs.
|     |                |          |
| PCA |         320 dB | NotKnown |Prob 75pct that a PCA is starting up now.
| PCA |         320 dB | NotKnown |Onset 2 hrs after flare.
|     |                |          |Can last 1-3 days after start.
|     |                |          |
| Aur | FoE=   3.0 mHz |          |
|     |                |          |
+-----+----------------+----------+--------------------------------------+
```

Figure 4.3.11.1.8. Sample advice file DIAS.ADV. The configuration file in figure 4.3.11.1.1 specifies that this file (DIAS.ADV) actually be named ZZDA17DEC235959.ADV.

```
+=====+===============+=========+=========================================+
| <ZZ><17DEC235959>             DIAS EXPLANATION       <Ver  2.00><30 Jun 92> |
+=====+===============+=========+=========================================+
|      A Very_Large flare occurred on the sun      1 hrs    50 mins ago.   |
|      DIAS predicts the following disturbances and effects on circuits:   |
+=====+===============+=========+=========================================+
|
ALERT [SID]: Sudden Ionospheric Disturbance effects are Likely
BECAUSE of the time that has passed since the flare <110 min>, and
| the circuit's geomag latitude <67 deg> and
| the current time of day <Morning>.
| The LOWEST USABLE FREQUENCY <LUF> is 22 mHz
| BECAUSE of the circuit path length <Long> and
| the current size of the flare <Med>.
| Typically, this condition can last minutes to several hours.
| The average duration for this size flare <Very_Large> is 6hr_05min.
|
ALERT [PCA]: Polar Cap Absorption effects are Likely to be starting up now
BECAUSE of the time that has passed since the flare <110 min>, and
| the circuit's geomag latitude <67 deg>, and
| whether or not protons are expected <Yes_or_NotK>.
| The apriori PROBABILITY that PCA effects are starting up now is 75pct
| BECAUSE of the sun spot number <SSN=150>.
| ONSET will occur 2 hours after the flare
| BECAUSE of the location of the flare on the sun disk <15W solar lon>.
| The IMPACT will be 320 dB based on a vertical loss of 16 dB.
| BECAUSE the level of degradation a circuit experiences depends on the
| circuit operating frequency <12 mHz>,
| and circuit time of day <nominally Day>.
| The DURATION will be NotKnown
| BECAUSE of the circuit geomag Lat <67 deg> and Lon <90 deg>.
|
RELAX [IS]: Ionospheric Storm effects are Not Likely
BECAUSE of the time that has passed since the flare <110 min>, and
| the circuit's geomag latitude <67 deg> and
| current time of day <Morning>.
|
ALERT [Aur]: Auroral E-Layer effects are Likely
BECAUSE of the circuit geomagnetic latitude <67 deg> and
| the geomag K-Index <4>.
| The AURORAL E-LAYER CRITICAL FREQUENCY <FoE> will be    3.0 mHz
| BECAUSE of the circuit geomagnetic latitude <67 deg> and
| the geomag K-Index <4>.
|
RELAX [AZA]: Auroral Zone Absorption effects are Not Likely
BECAUSE of the time that has passed since the flare <110 min>, and
| the circuit's geomag latitude <67 deg> and
| current time of day <Morning>.
|
+-----+---------------+---------+-----------------------------------------+
```

Figure 4.3.11.1.9. Sample explanation file DIAS.WHY. The configuration file in figure 4.3.11.1.1 specifies that this file (DIAS.WHY) actually be named ZZDA17DEC235959.WHY.

```
METHOD        = L-LB
COMMENT       = ------------------- WRITE DIAS OUTPUT FILES ---------------
VER           = Ver  2.00
VDATE         = 30 Jun 92
OP_DIGRAPH    = ZZ
FILE_ID       = 17DEC235959
FNAME         = ZZDA17DEC235959
FCCONTR       = 0
FUNCTION1     = CALL HelpW hlpd.htx HlpSys  1 5 80 25 c
FUNCTION2     = CALL HelpW hlpd.htx HlpDIAS 1 5 80 25 c
FUNCTION3     = CALL HelpW rule.htx 0       1 5 80 25 c
FUNCTION4     = CALL HelpW ZZDA17DEC235959.in  0       1 5 80 25 c
FUNCTION5     = CALL HelpW ZZDA17DEC235959.adv 0       1 5 80 25 c
FUNCTION6     = CALL HelpW ZZDA17DEC235959.why 0       1 5 80 25 c
FUNCTION7     = CALL HelpW ZZDA17DEC235959.out 0       1 5 80 25 c
FUNCTION8     = CALL HelpW dias.bug 0       1 5 80 25 c
DONE          = ~LocDispl
NEEDFLR       = |
NEEDSID       = |
NEEDPCA       = |
NEEDIS        =
NEEDAUR       = T
NEEDAZA       =
FOP           = ~12.
DIS           = 2700.
GMLAT         = 67.
GMLON         = 90.
GGLAT         = 54.
GGLON         = 92.
SSN           = 150.
SSNAZA        =
KA            = ?KA
KP            = 4.2
APINDEX       = 11.
APRANGE       = ?APRANGE
DBDATE        = 19921022
DATE          = 10/22/1992
TIME          =  9:35 am
YR            = 1992.
MO            = 7.
HOURUT        = 5.
UTQ           = 06
UTQ21         = 06
```

Figure 4.3.11.1.10 (p. 1 of 3). Sample output file DIAS.OUT. The configuration file in figure 4.3.11.1.1 specifies that this file (DIAS.OUT) actually be named ZZDA17DEC235959.OUT.

```
TODFLR         = Morning
TODCUR         = Morning
GLT            = 09
TODPOLAR       = NotAppl
TODPCA         = Day
TODIS          = Morning
FLRSZINIT      = Very_Large
FLRLOC         = 15W
PROTONS        = Yes_or_NotK
SIDINIT        = Substantial
FLRDUR         = ?FLRDUR
TPFH           = 2
TPFM           = 110.
FLRSZCUR       = Med
EVSID          = Likely
HILATSID       = NotAppl
PATH           = Long
UFA            = 22
UFABOVE        = 22
EVPCA          = Likely
PCAPROT        = Yes
TENMEVFLUX     = 320.
PCAABS         = ?PCAABS
PCAABSN        = ?PCAABSN
PCAAF          = ?PCAAF
AFRANGE        = ?AFRANGE
PCAPROB        = 75pct
PCAONSET       = 2.5
PCALOSS        = DayLoss
PCAPLOSS       = 16
PCAOLOSS       = 320
PCADUR         = NotKnown
EVIS           = NotLikely
ISPROB         = ?ISPROB
ISLOSS         = ?ISLOSS
ISLOSSN        = ?ISLOSSN
ISIMPACT       = ?ISIMPACT
ISDUR          = ?ISDUR
TECHANGE       = ?TECHANGE
TPMPO          = ?TPMPO
EVAUR          = Likely
AURFOE         = 3.0
EVAZA          = NotLikely
AZAQ1          = ?AZAQ1
AZAPROB        = ?AZAPROB
AZAABS         = ?AZAABS
```

Figure 4.3.11.1.10 (p. 2 of 3). Sample output file DIAS.OUT.

```
SIDMSG1        = Mins-Hrs
SIDMSG2        = Effects can last minutes to several hrs.
SIDMSG3        =
ESMSG1         =
ESMSG2         =
ESMSG3         =
PCAMSG1        =
PCAMSG2        = Can last 1-3 days after start.
PCAMSG3        =
ISMSG1         =
ISMSG2         =
ISMSG3         =
AZAMSG1        =
AZAMSG2        =
AZAMSG3        =
AURMSG1        =
AURMSG2        =
AURMSG3        =
FCHEADER       = 0.
2DATIN         = 0.
FUNCTION9      = CALL HelpW header.htx AZAHd    1 5 80 25 c
FUNCTION10     = CALL HelpW header.htx Reserved  1 5 80 25 c
HELPDIASB      = 0
SYSTIME        = 0
DURFLR         = 3_Hr
X              = 3_Hr
SIDDUR         = 6hr_05min
SIDCUR         = Med
U              = 22
PCADUR4        = 0
P              = 16
FCOUT          = 0
```

Figure 4.3.11.1.10 (p. 3 of 3). Sample output file DIAS.OUT.

4.3.11.1.11 - FCDIAS Road Map - 1 page.

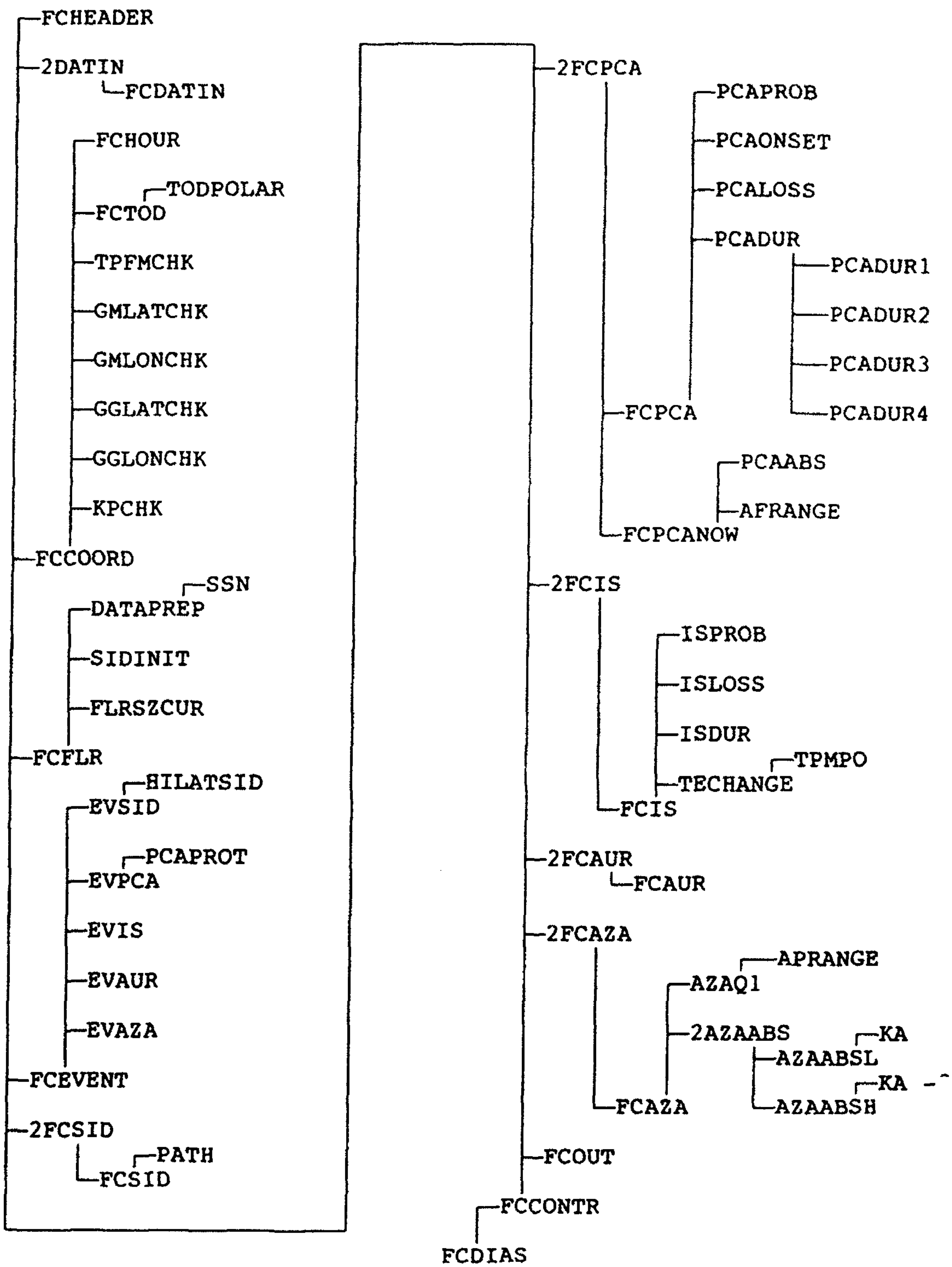


Figure 4.3.11.1.11: Roadmap of FCDIAS expert system, starting at knowledge base FCDIAS.KBM. Forward chains are expressed as downward links; backward chains as upward links.

4.3.11.1.12 - FCDIAS Parameter Road Map - 5 pages.

FCDIAS PARAMETER MAP
(page 1 of 5)

- FCHEADER
- 2DATIN
  - FCDATIN — FcDatin
    - SetfKey
    - DataEntry
    - ResetFkey
- FCCOORD
  - FCHOUR
    - HourUt
    - UTQ21
  - FCTOD — FCTod
    - TODPOLAR — TODPolar
      - Mo
      - GgLat
      - TODPolar
    - TODCur
  - TPFMCHK — TPFMChk — TPFM
  - GMLATCHK — GgLatChk — GgLat
  - GMLONCHK — GmLonChk — GmLon
  - KPCHK — KpChk — Kp
- FCFLR
  - DATAPREP
    - SSN — SSN — SSNTable
  - SIDINIT — SIDInit
    - FlrSzInit
    - TODPolar
    - TODFlr
  - FLRSZCUR — FlrSzCur
    - FlrSzInit
    - TPFM

```
|
|        ┌HILATSID── HILatSID ──┬── TODPolar
|        |                      └── TPFM
|        |
|  ┌EVSID┴── EvSID ──┬── TPFM
|  |                 ├── GmLat
|  |                 └── TODCur
|  |
|  |     ┌PCAPROT── PCAProt ── TPFM
|  |     |
|  ├EVPCA┴── EvPCA ──┬── TPFM
|  |                 └── GmLat
|  |
|  ├EVIS── EvIS ──┬── TODCur
|  |              ├── GmLat
|  |              └── TPFM
|  |
|  ├EVAUR── EvAUR ──┬── KP
|  |                └── GmLat
|  |
|  ├EVAZA── EvAZA ──┬── GmLat
|  |                ├── TPFM
|  |                └── TODCur
|  |
├FCEVENT
|
├2FCSID
|  |         ┌PATH── Path ── Dis
|  |         |
|  └FCSID ───┴──┬── HiLatSID
|               ├── FlrSzCur
|               └── UFA
|
```

FCDIAS PARAMETER MAP
(page 3 of 5)

```
|
|-2FCPCA
|   |
|   |         -PCAPROB  —— PCAProb  ———— SSN
|   |        |
|   |        |-PCONSET  —— PCAOnset ———— FlrLoc
|   |        |
|   |        |-PCALOSS  —— PCALoss —┬——— TODPCA
|   |        |                      └—— Fop
|   |        |
|   |        |-PCADUR————— GmLon
|   |        |     |
|   |        |     |-PCADUR1 — PCADur —— GmLat
|   |        |     |
|   |        |     |-PCADUR2 — PCADur —— GmLat
|   |        |     |
|   |        |     |-PCADUR3 — PCADur —— GmLat
|   |        |     |
|   |        |     └PCADUR4 — PCADur —— GmLat
|   |        |
|   |-FCPCA -┘
|   |         -PCAABS——— PCAAbs—┬—— TODPCA
|   |        |                  └—— TenMEVFlux
|   |      -AFRANGE—— AfRange —— PCAAf
|   |     |
|   └FCPCANOW
|
```

FCDIAS PARAMETER MAP
(page 4 of 5)

```
├2FCIS─────────────── EvIS
│    │
│    │   ┌ISPROB──── IsProb─┬── UTQ
│    │   │                  └── Mo
│    │   │
│    │   ├ISLOSS ──── ISLoss─┬── ISProb
│    │   │                   ├── TODIS
│    │   │                   ├── GmLat
│    │   │                   └── Kp
│    │   │
│    │   ├ISDUR──── ISDur─┬── Kp
│    │   │                ├── GmLat
│    │   │                └── ISDur
│    │   │
│    │   │        ┌TPMPO──── TPMPO ──── TPFH
│    │   │        │
│    │   ├TECHANGE── TEChange─┬── TPMPO
│    │   │                    └── TODCur
│    │   │
│    └FCIS
│
├2FCAUR─────────────── EvAUR
│    │
│    └FCAUR──────────┬── GmLat
│                    ├── Kp
│                    └── AurFoE
│
```

FCDIAS PARAMETER MAP
(page 5 of 5)

```
  |
  |
  |
  |2FCAZA------------------ EvAZA
  |
  |                 ┌APRANGE --- ApRange ---- ApIndex
  |                 |
  |      ┌AZAQ1-----┴AZAQ1-┬---- GLT
  |      |                 └---- GmLat
  |      |
  |      ├2AZAABS------┬------ SSN
  |      |   |         └------ Abs
  |      |   |
  |      |   |   ┌KA--- KA-┬---- GmLon
  |      |   |   |         └---- GmLat
  |      |   |   |
  |      |   ├AZAABSL-┬------ Fop
  |      |   |        └------ AZAAbs
  |      |   |
  |      |   |   ┌KA---- KA-┬---- GmLon
  |      |   |   |          └---- GmLat
  |      |   |   |
  |      |   └AZAABSH-┬------ Fop
  |      |            └------ AzAAbs
  |      |
  |      └FCAZA
  |
  ├FCOUT
 ┌FCCONTR
 |
1DIAS
```

4.3.12 CONTROL POINT SELECTOR

4.3.12.1 Module Description

(1) Developers - R.B. Rose and B.J. Satterlee.

(2) Date Created - Scheduled for future development.

(3) Function - The purpose of this module is to develop a ruleset to select the most critical and/or vulnerable D-region passage points or E- or F- region ionospheric reflection points on a transpolar HF circuit. It is at these points that signal absorption or loss is calculated, or layer MUF is modified.

(4) Called By Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) -

(6) Parameters Returned (Outputs) -

(7) Common Block Returned -

(8) Functions, Subroutines, and Knowledgebases Referenced -

(9) References - None. Original work.

(10) Change History - Scheduled for incorporation in future releases.

4.3.12.2 - Control Point Selector Flow Diagram

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4.3.13 COORDINATES RULESET (FCCoord.kbm)

4.3.13.1 Module Description

(1) Developers - D.R. Lambert

(2) Date Created - FY 92.

(3) Function - The Coordinates Module (FCCoord.kbm) initializes and sets values for geophysical and time parameters. The reasons for some of these parameters being required by DIAS are detailed below.

Universal Time Coordinated (UTC) is needed to determine the probability of an ionospheric storm. An empirical relationship has been established between this probability and UTC, the month, and the time past the flare (TPF). Currently, this relationship is tentative and needs to be reviewed and validated.

The local Time of Day (TOD) at the HF circuit's control point indicates whether it is daylight and, if so, how high the sun is in the sky (solar zenith angle). Since several of the disturbance phenomena are daylight-driven, this information is needed to determine whether or not they can occur. For example, a SID can occur only during daylight, and AZA only during morning hours. Note that the distinction between times of day becomes blurred at polar latitudes during certain months of the year when the sun remains above, or below, the horizon 24 hours a day. In the FCDIAS SID module, the parameter TODPolar is used to override the TOD parameter during periods of 24-hour day and 24-hour night.

Month (Mo) is needed because the month partly determines how high the sun is in the sky, which, to a large extent, determines the magnitude of its effect on the ionosphere. At high latitudes during certain winter months, SIDs are less likely and ionospheric storms more likely.

The Geographic Latitude (GgLat) is needed in describing the parameter TODPolar, which is used to determine whether 24-hour day or 24-hour night conditions apply. The Geographic Longitude (GgLon) is included for completeness.

The Geomagnetic Latitude (GmLat) and Geomagnetic Longitude (GmLon) are needed because the values of ionospheric disturbance parameters are generally a function of the earth's magnetic field. In particular, the geomagnetic coordinates of the circuit's ionospheric E- or F-layer reflection (control) points or D-layer crossing (passage) points are needed because those are the points at which an HF circuit is vulnerable to ionospheric disturbances. In addition, disturbance effects

generally vary with latitude. For example, the effects of an SID are more pronounced the lower the latitude. Those of a PCA are limited to the polar cap. And those of auroral disturbances affect locations between 60 and 75 degrees north. In the absence of automated inputs, one may estimate the latitude of a circuit's F-layer control point by looking at a map and using the HF path midpoint. D- and E-layer control points require more sophisticated derivation.

Time Past Flare (TPF) is needed because the expected ionospheric disturbance effects depend on how long ago the flare occurred. The effects are caused by three different types of solar emissions (X-rays, high-energy particles, and low-energy particles) that arrive at the earth in three different time windows. The solar longitude (FlrLoc) is needed because the arrival of the high-energy particles in the earth's polar regions depends on the geographical region on the sun in which the flare occurred. These particles are ejected at about two-thirds the speed of light and arrive between 2 and 6 hours after the flare.

(4) Called By Subroutine, Function, or Knowledgebase - FCContr.kbm.

(5) Parameters Passed (Inputs) - Universal Time Coordinated (UTC) to nearest hour (**HourUT**, values: 00,01,...,23), Current local Time of Day at the HF circuit's control point (**TODCur**, values: Sunrise, Morning, Noon, Afternoon, Sunset, PreMNight, MidNight, PostMNight), Sun Spot number (**SSN**, values: 1 to 200+), Month (**Mo**, values: 1, 2, ..., 12), Geographic Latitude (**GgLat**, values -90 to 90 degrees), Geographic Longitude (**GgLon**, values: -180 to 180 degrees), Geomagnetic Latitude (**GmLat**, values -90 to 90 degrees), Geomagnetic Longitude (**GmLon**, values -180 to 180 degrees), solar longitude of the Flare Location (**FlrLoc**), Planetary Geomagnetic K-Index (**Kp**, numeric values: 0-9), Time Past Flare in Minutes (**TPFM**, numeric value).

(6) Parameters Returned (Outputs) - Universal Time, quarter-day (**UTQ**, values: 00,06,12,18), Universal Time, quarter-day, with last quarter-day split (**UTQ21**, values: 00,06,12,18,21), Polar 24-hour day/night (**TODPolar**, values: 24HrDay, 24HrNight, NotAppl).

(7) Common Block Returned - Global Variables

(8) Functions, Subroutines, and Knowledgebases Referenced - FCHour.kbm, FCTOD.kbm.

(9) References - None.

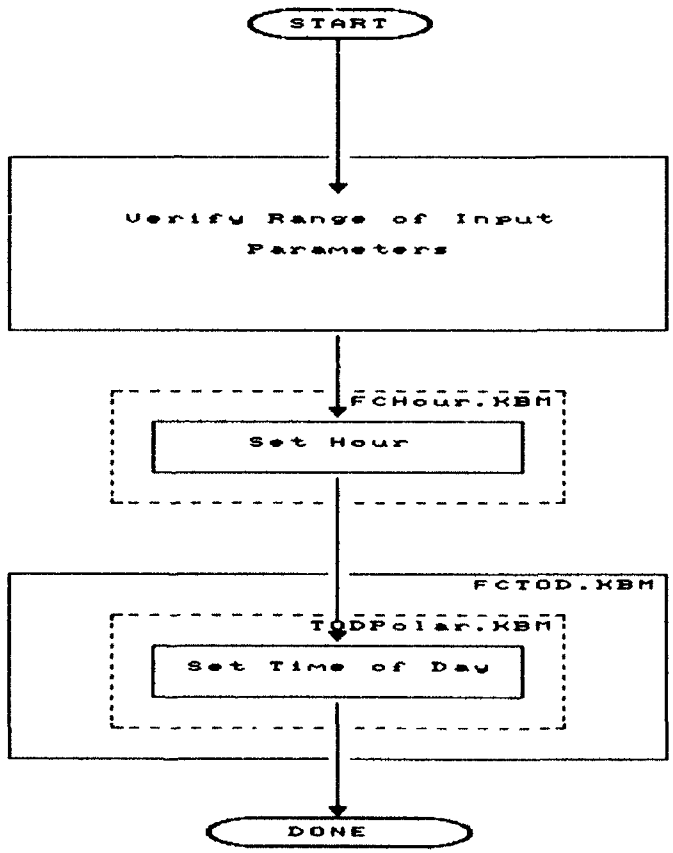
(10) Change History - Assembled FY 92.

4.3.13.2 - Coordinates Ruleset (FCCoord.kbm) Flow Diagrams - 4 pages

FCCoord Module

SET GEOPHYSICAL AND TIME PARAMETERS

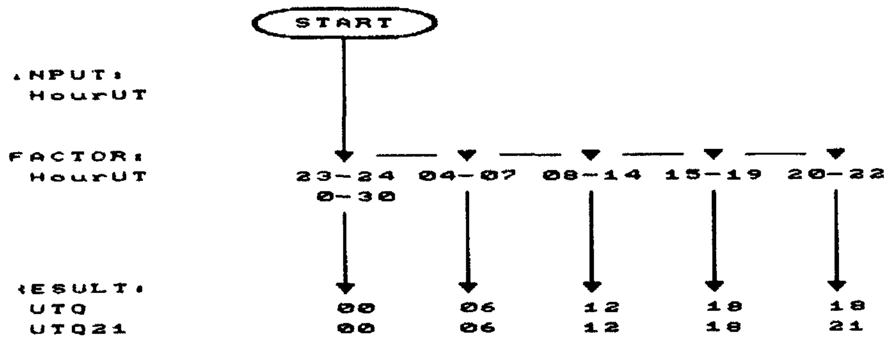
INPUT:
- Mo
- GgLat
- HourUT
- TODCur



FCCoord

SET GEOPHYSICAL AND TIME PARAMETERS

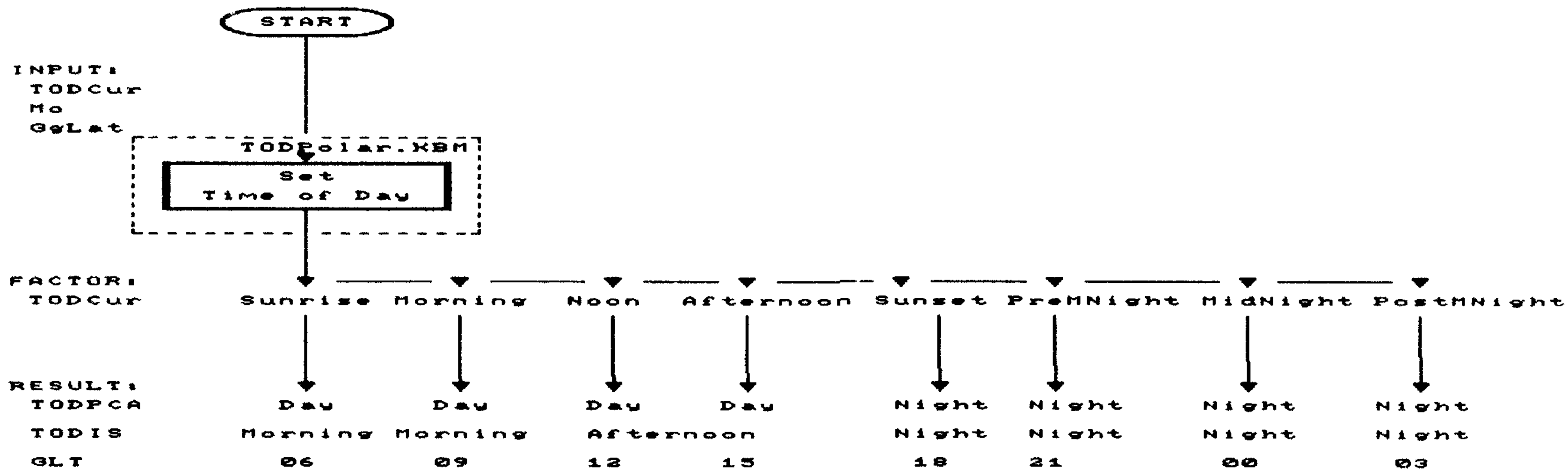
FCHour Submodule



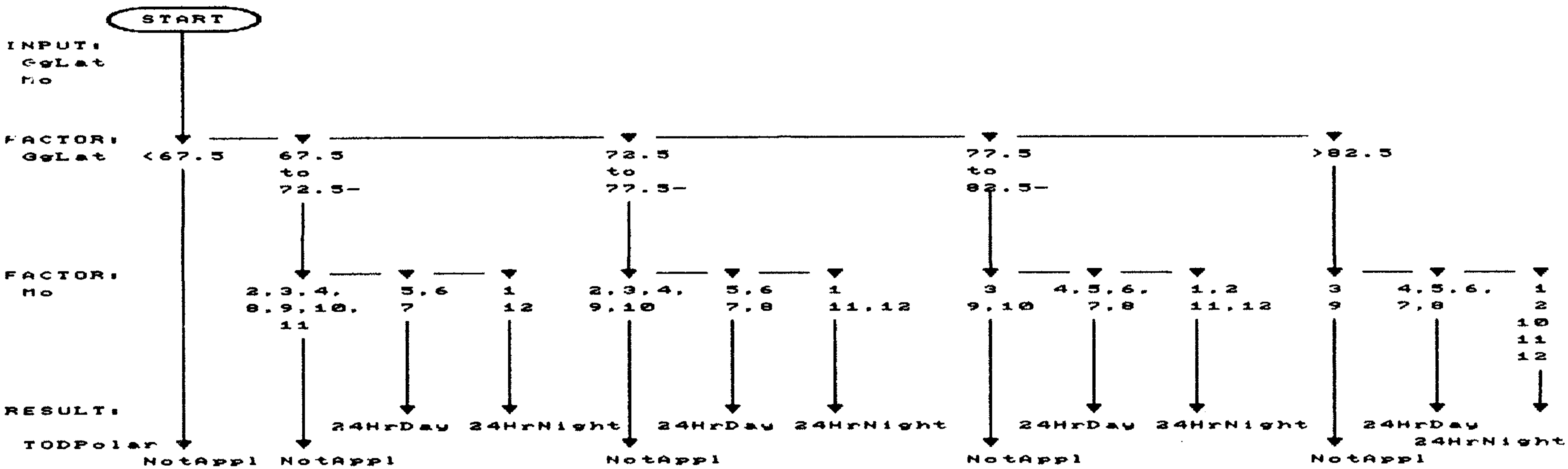
FCCoord

SET GEOPHYSICAL AND TIME PARAMETERS

FCTOD Submodule



FCCoord
SET GEOPHYSICAL AND TIME PARAMETERS
TODPolar Submodule



4.3.14 FLARE RULESET (FCFlr.kbm)

4.3.14.1 Module description (14 Rules)

(1) Developers - R.B. Rose. Edit and FCL Ver - D.R. Lambert.

(2) Date Created - 22 June 1989.

(3) Function - The Flare Ruleset (FCFlr.kbm), which is concerned with the solar flare itself, initializes and sets values for the flare's parameters, including its initial SID impact and its current size.

DIAS considers flare size an indicator of potential SID magnitude and the existence of high- and low-energy particles. Flare size is expressed in terms of the integrated 1-8 angstrom solar X-ray flux. A flare is deemed to have begun when this flux rises above 0.1 ergs as measured from sensors on the GOES weather satellites. The X-ray flux is an indicator of the amount of HF absorption during a SID, the presence of high- and low-energy particles, and the ionospheric disturbances the particles create. For our needs, the correspondence may be expressed as

Flare Size	Disturbances Expected
Very_Large	Large and multiple disturbances.
Large	Major HF outage and geomagnetic storms.
Med(ium)	Minor HF outage and geomagnetic storms.
Small	Minor short-lived HF effects.
No_Flare	None.

Given the time that the flare occurred, this module uses solar activity, initial flare characteristics, and the time past the flare to estimate the flare's initial SID impact and current size. The Current Flare Size is estimated by the FlrSzCur submodule, which relates it to the recovery of the Lowest Usable Frequency (LUF). This determination is based on a model of 1-8 angstrom X-ray energy decay. The model was developed from 237 observed X-ray bursts measured between 1 January and 10 March 1989 by sensors on the GOES weather satellite.

The current smoothed Sun Spot number (SSN) is needed by DIAS because more and larger flares occur during periods of high SSN (i.e., during solar maxima). This causes an increase in the occurrence of SIDs, PCAs, Ionospheric Storms, and AZAs. Note, however, that while Ionospheric Storms are more frequent during solar maxima, they are more intense and have greater impact at solar minima.

When the Sun Spot number (SSN) is not available directly from the input file, Month (Mo) and Year (Yr) may be used to

retrieve it from the file SSNTABLE.TBL, which contains a user-updatable SSN-prediction table.

(4) Called By Subroutine, Function, or Knowledgebase - FCCONTR.kbm.

(5) Parameters Passed (Inputs) - Initial Flare Size (**FlrSzInit**, values - No_Flare, Small, Med, Large, Very_Large), Time of Day Flare (**TODFlr**, Values - Sunrise, Morning, Noon Afternoon, Sunset, PreMNight, MidNight, PostMNight), Month (**Mo**, numeric values: 1-12), Year (**Yr**, numeric value: 1992,1993,...), SunSpot number (**SSN**, numeric values: 0-about 200), Time Past Flare in minutes (**TPFM**, numeric values), Universal Time (**HourUT**, in hours, values 0-23), Current Flare Size (**FlrSzCur**, values: Nil,Small, Medium, Large, Very_Large), Time of Day Polar (TODPolar, values: 24HrDay, 24HrNight, NotAppl, InErrGgLat).

(6) Parameters Returned (Outputs) - Expected Initial SID effect (**SidInit**, values: Negligible, Slight, Moderate, Substantial, Severe), Flare Duration (**DurFlr**, values: 0_Hr, 1_Hr, 2_Hr, 3_Hr, 6_Hr), Universal Time Quarterly (**UTQ**, values: 00,06,12,18), Modified Universal Time Quarterly with hour 21 added (**UTQ21**, values: 00,06,12,18), Current Flare Size (**FlrSzCur**, values: Nil, Small, Med, Large, Very_Large, InErrTPFM).

(7) Common Block Returned - *Global Variables.*

(8) Functions, Subroutines, and Knowledgebases Referenced - DataPrep.kbm, SSN.kbm via DataPrep.kbm, SIDInit.kbm, FlrSzCur.kbm.

(9) References -

Rose, R. B. 1989. A table empirically derived from 237 flares that occurred between 1 Jan and 10 Mar 1989, working papers, 1989.

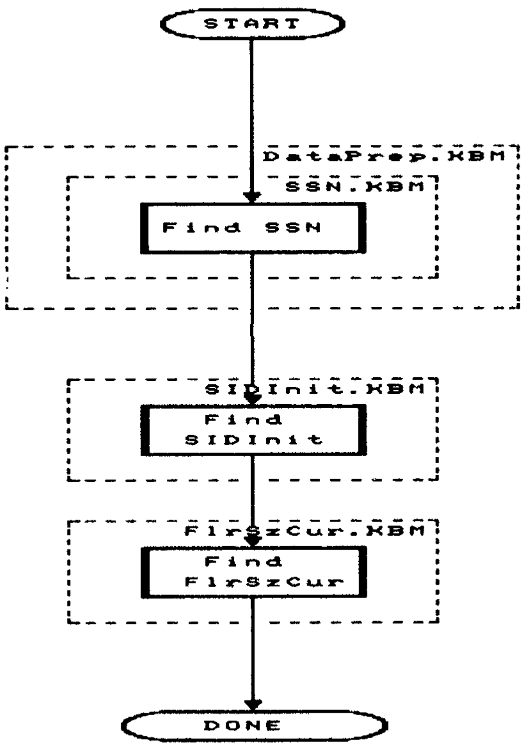
(10) Change History - Original version 22 June 1989; FC conversion 21 December 1989.

4.3.14.2 - Flare Ruleset (FCFlr.kbm) Flow Diagrams - 4 pages

FCFlr Module

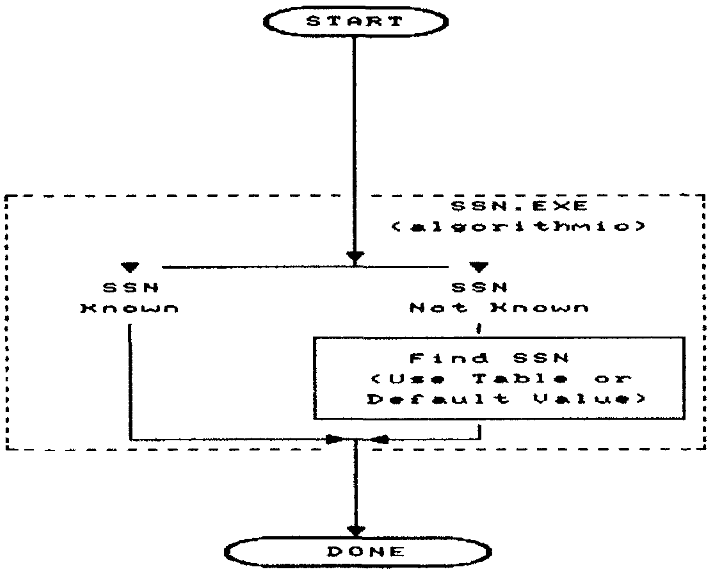
INITAL FLARE PARAMETERS

INPUT:
SSN (or Yr, Mo)
FlrSzInit
TODFlr
TPFM
Mo
GgLat



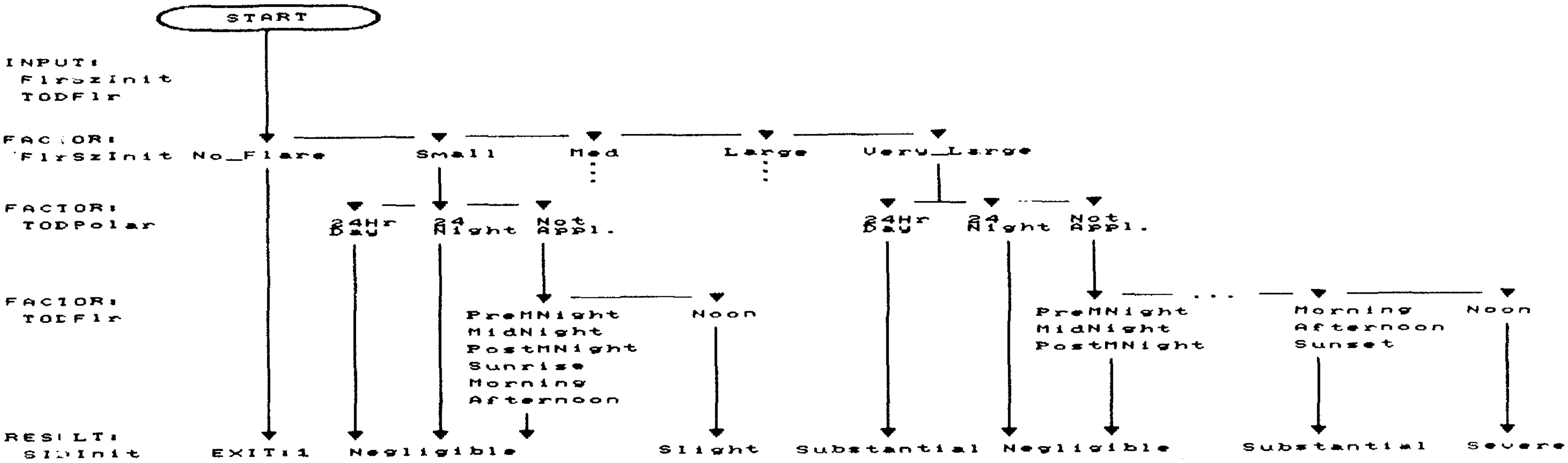
FCF1r
INITIAL FLARE PARAMETERS
DataPrep Submodule

INPUT:
Yr
Mo

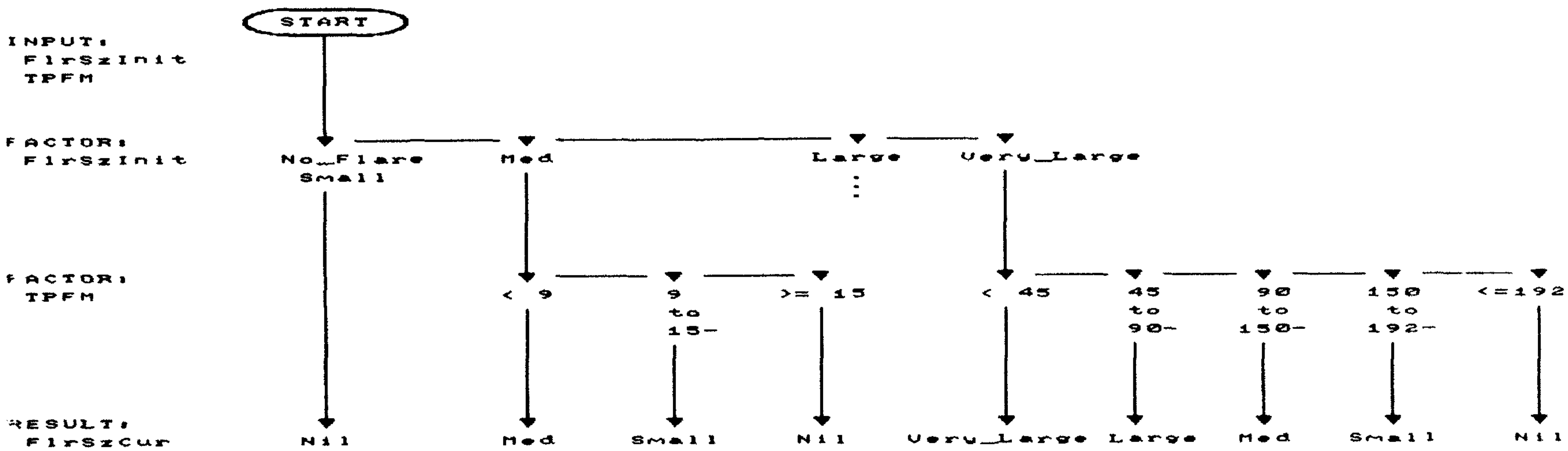


RESULT:
SSN

FCFlr
INITIAL FLARE PARAMETERS
SIDInit Submodule



FCFlr
INITIAL FLARE PARAMETERS
FlrSzCur Submodule



4.3.15 DISTURBANCE EVENT LIKELIHOOD RULESET (FCEvent.kbm)

4.3.15.1 Module Description (8 Rules)

(1) Developers - R.B. Rose. Edit and FC ver - D.R. Lambert.

(2) Date Created - 1 August 1989.

(3) Function - The Event Module (FCEvent.kbm) controls activation of the DIAS ruleset modules that evaluate the five main near-earth ionospheric disturbances. These disturbances (and corresponding DIAS Modules) are: Sudden Ionospheric Disturbance (**FCSID.kbm**), Polar Cap Absorption (**FCPCA.kbm** and **FCPCANOW.kbm**), Ionospheric Storm (**FCIS.kbm**), Auroral E (**FCAur.kbm**), and Auroral Zone Absorption (**FCAZA.kbm**). Each disturbance has a certain probability of occurrence, with simultaneous effects from multiple disturbances common at high latitudes. The Event Module assesses whether each disturbance is "Likely" or "NotLikely" to occur at the present time. Its evaluation considers current conditions, as represented by time past flare, flare size, circuit latitude, and other key parameters. "Likely" disturbances are subsequently evaluated in detail; "NotLikely" ones are not.

Time Past Flare (TPF) provides the means for driving this module with the DIAS 120-Hour Event Clock, which is started at flare onset. The likely time course of each type of disturbance is governed to a great extent by TPF--how far one is along the time track from flare onset at T0 hours to the expected subsiding of its effects 5 days later (T120 hours). This is because three different types of solar emissions arrive in the earth's environment in three different time windows. First, 1-8 angstrom X-rays arrive simultaneously with the light we observe visually, approximately 8 minutes after leaving the sun. These X-rays cause the immediate SID effect. Second, high-energy particles arriving approximately 0.5 to 4 hours later may cause a PCA disturbance. And third, low-energy particles that arrive 24-36 hours after the flare may cause a geomagnetic storm, an ionospheric storm, and/or auroral disturbances.

(4) Called By Subroutine, Function, or Knowledgebase - FCContr.kbm.

(5) Parameters Passed (Inputs) - Corrected Geomagnetic Latitude (**GmLat**, values in degrees -90 to 90), Geomagnetic K-Index (**Kp**, numeric values: 0-9), Time Past Flare in Minutes (**TPFM**, numeric value), Current Time of Day (**TODCur**, values: Sunrise, Morning, Noon, Afternoon, Sunset, PreMNight, MidNight, PostMNight), Time of Day Polar (**TODPolar**, values: 24HrDay, 24HrNight, NotAppl), whether Protons are expected (**Protons**, values: Yes_or_NotK, No).

(6) Parameters Returned (Outputs) - Sudden Ionospheric Disturbance likelihood (**EvSID**, values: Likely, NotLikely), likelihood of SID at High Latitudes (**HiLatSID**, values: Likely, NotLikely, NotAppl), Polar Cap Absorption likelihood (**EvPCA**, values: Likely, NotLikely, InProgress), Ionospheric Storm likelihood (**EvIS**, values: Likely, NotLikely), likelihood of Auroral E-Layer effects (**EvAur**, values: Likely, NotLikely), Auroral Zone Absorption likelihood (**EvAZA**, values: Likely, NotLikely).

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - EvSID.kbm, HiLatSID.kbm via EvSID.kbm, EvPCA.kbm, PCAProt.kbm via EvPCA.kbm, EvIS.kbm, EvAur.kbm, EvAZA.kbm.

(9) References -

1. Bennett, S. 1966. "**A Proposal for a Real Time Frequency Forecasting and Management System**" AVCO Report RAD-B383-425 for NOLC, Corona, CA, 4 March 1966.

2. NATO-AGARD. 1969. "**Radio Wave Propagation**," NATO-AGARD Series 29, pages III-36 to III-47, July 1969.

3. Elkins, T.J. 1973. "**An Empirical Model of the Polar Ionosphere**," AFCRL Technical Report TR-73-0331, 23 May 1973.

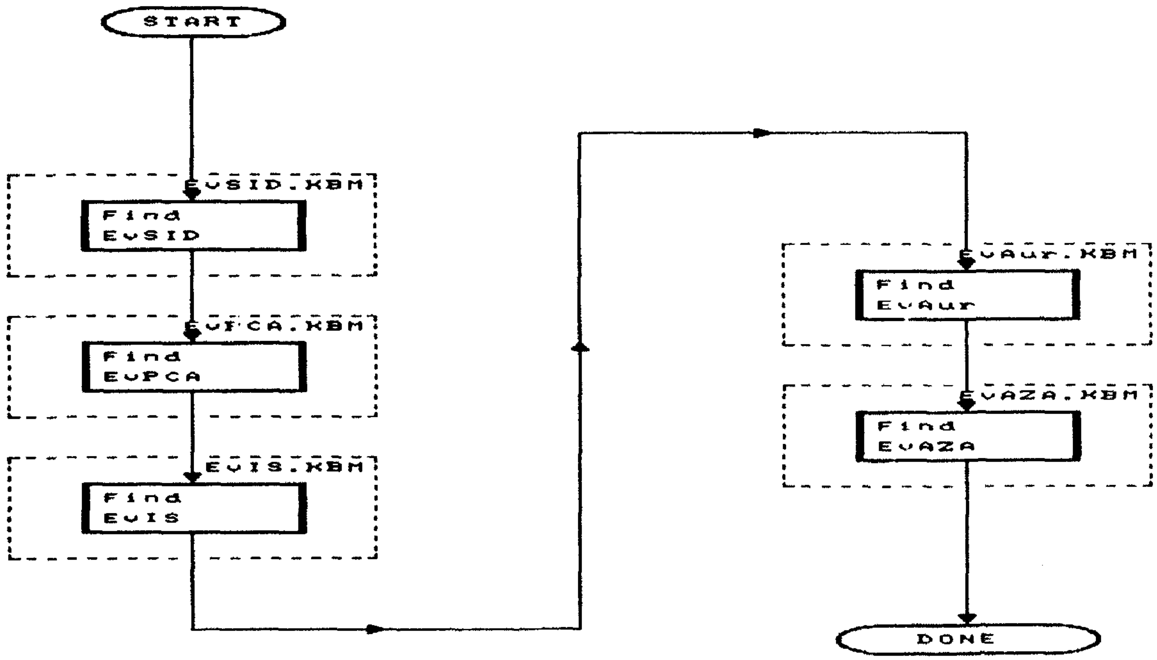
4. Stonehocker. 1969. "**Ionospheric Forecasting**," NATO-AGARD Proceedings no.49, pages 9-1 to 9-12, January 1969.

(10) Change History - Original 1 August 1989; Revision 1.5 September 1989; FC conversion 21 December 1989. Rev 20 Jun 1991.

4.3.15.2 - Disturbance Event Likelihood Ruleset (FCEvent.kbm)
Flow Diagrams - 8 pages

FCEvent Module
DETERMINE LIKELY EVENTS

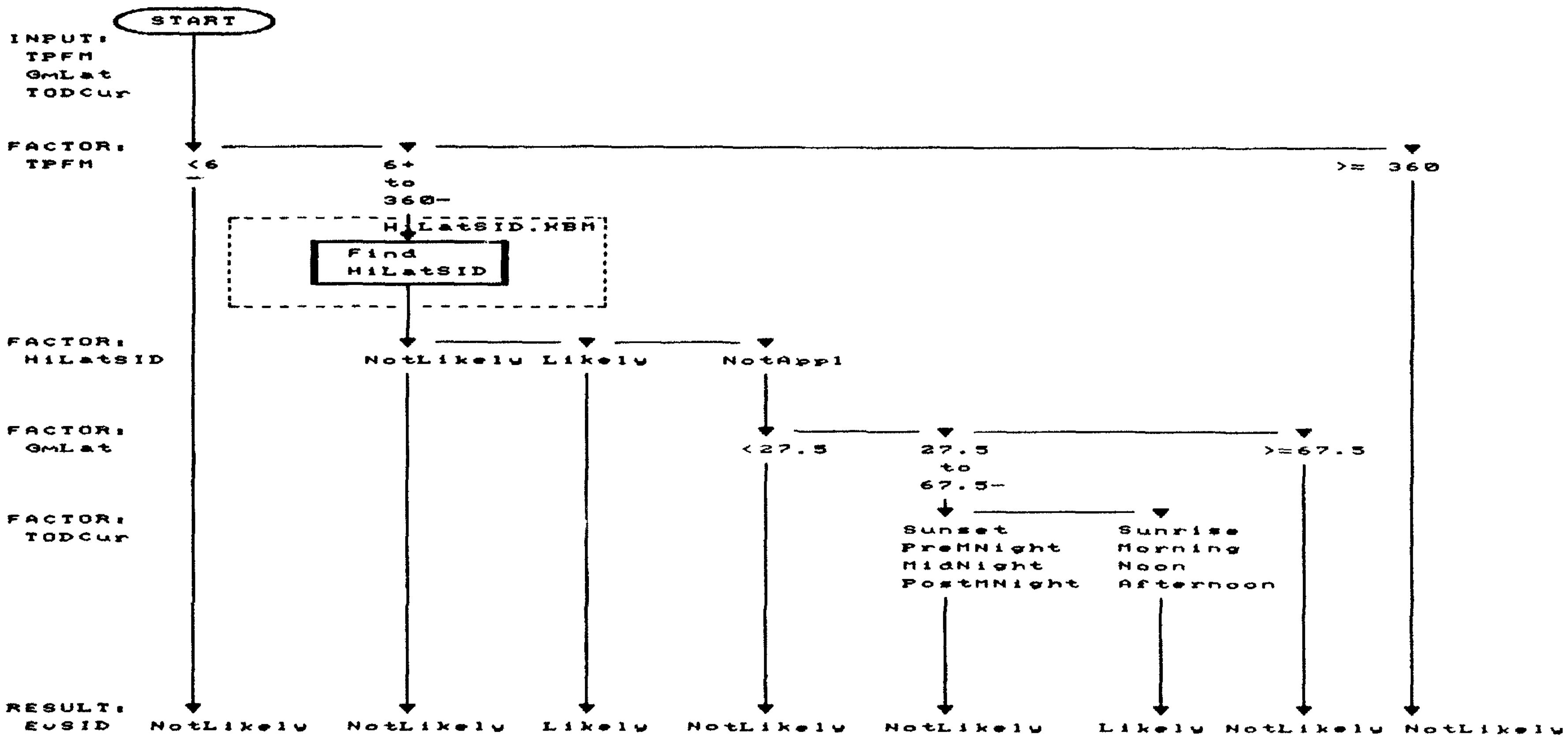
INPUT:
- TPFM
- GmLat
- TODCur
- TODPolar
- Protons
- Kp
- Mo
- GgLat



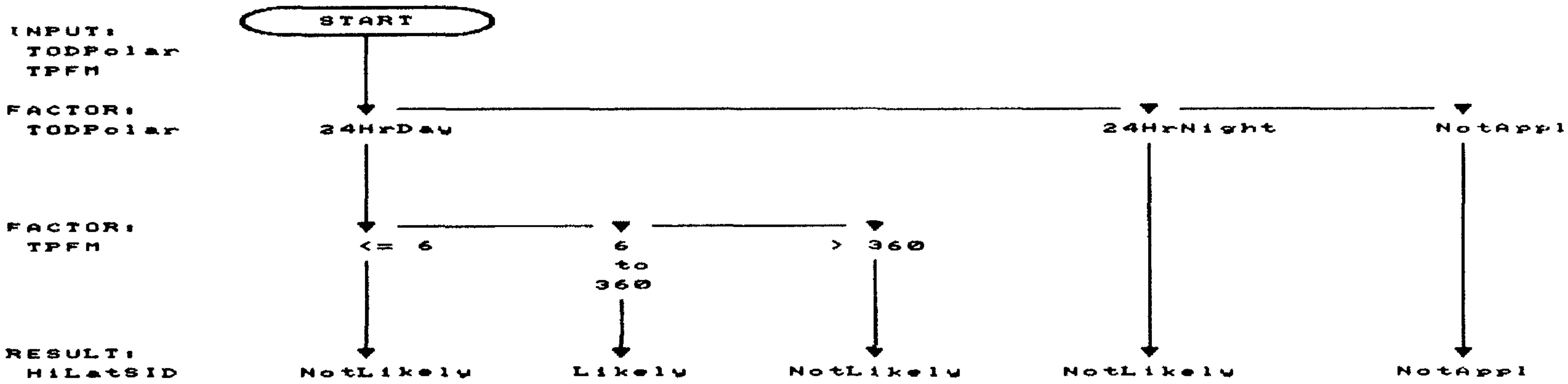
FCEvent

DETERMINE LIKELY EVENTS

EvSID Submodule

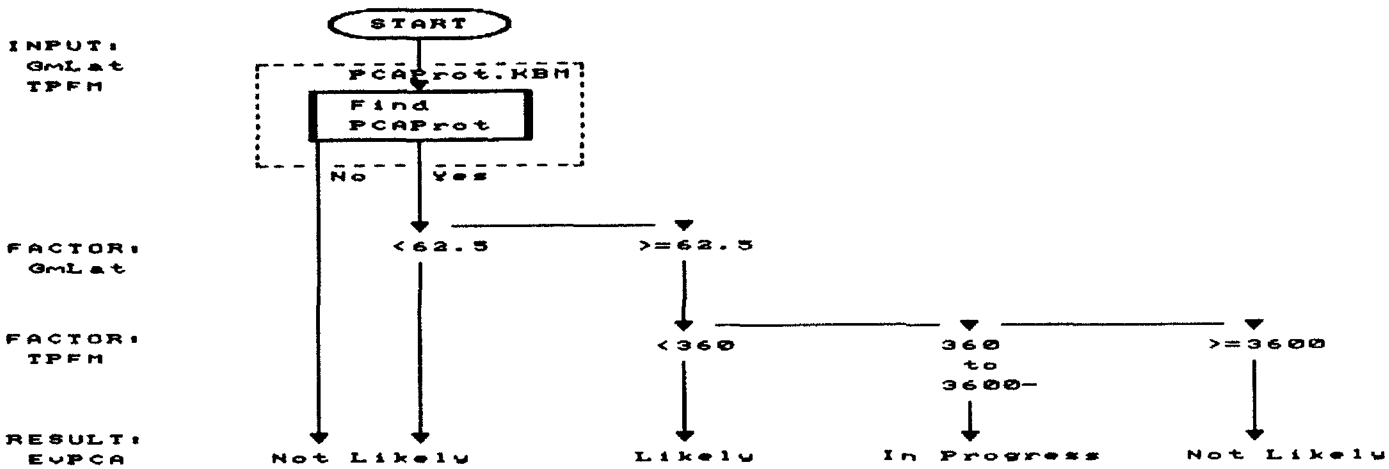


FCEvent
DETERMINE LIKELY EVENTS
EvSID: HiLatSID Submodule



FCEvent

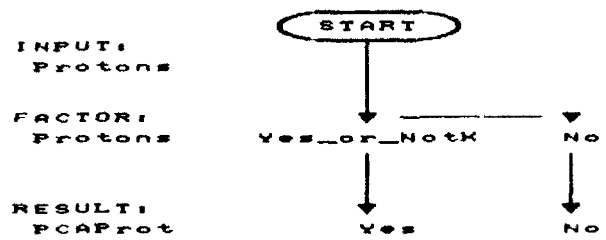
DETERMINE LIKELY EVENTS
EvPCA Submodule



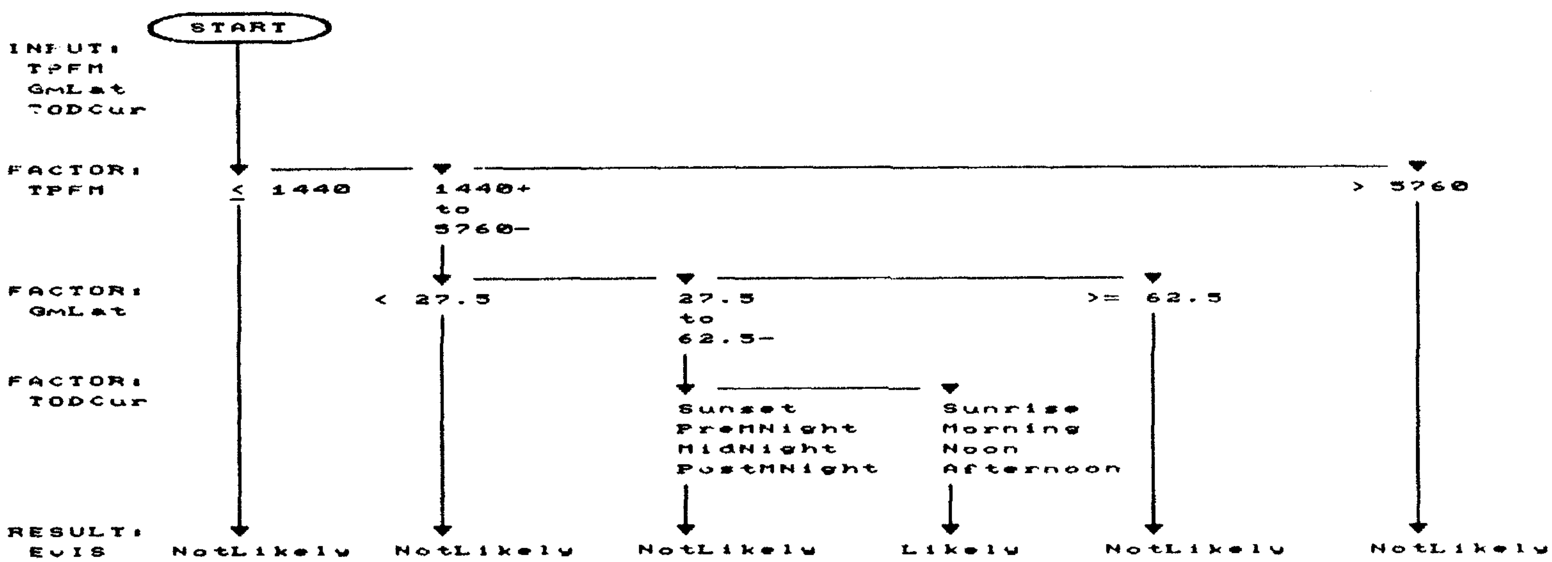
FCEvent

DETERMINE LIKELY EVENTS

EVPCA: PCAProt Submodule



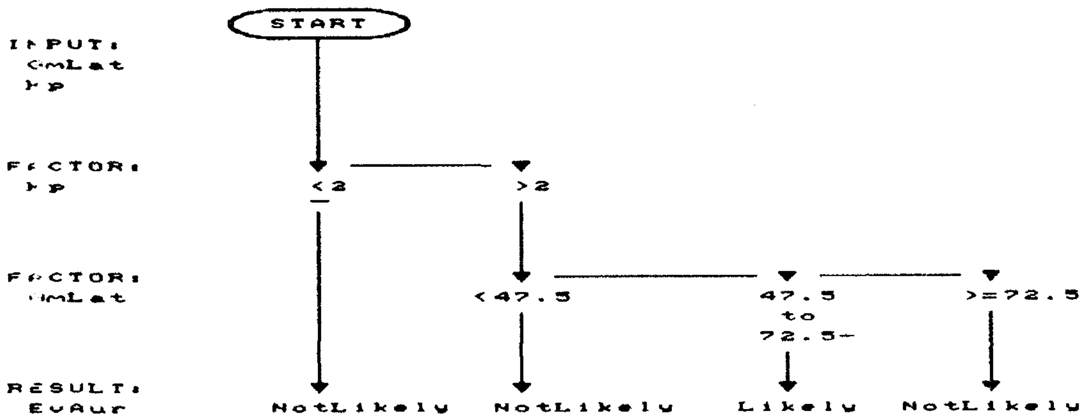
FCEvent
DETERMINE LIKELY EVENTS
EvIS Submodule



FCEvent

DETERMINE LIKELY EVENTS

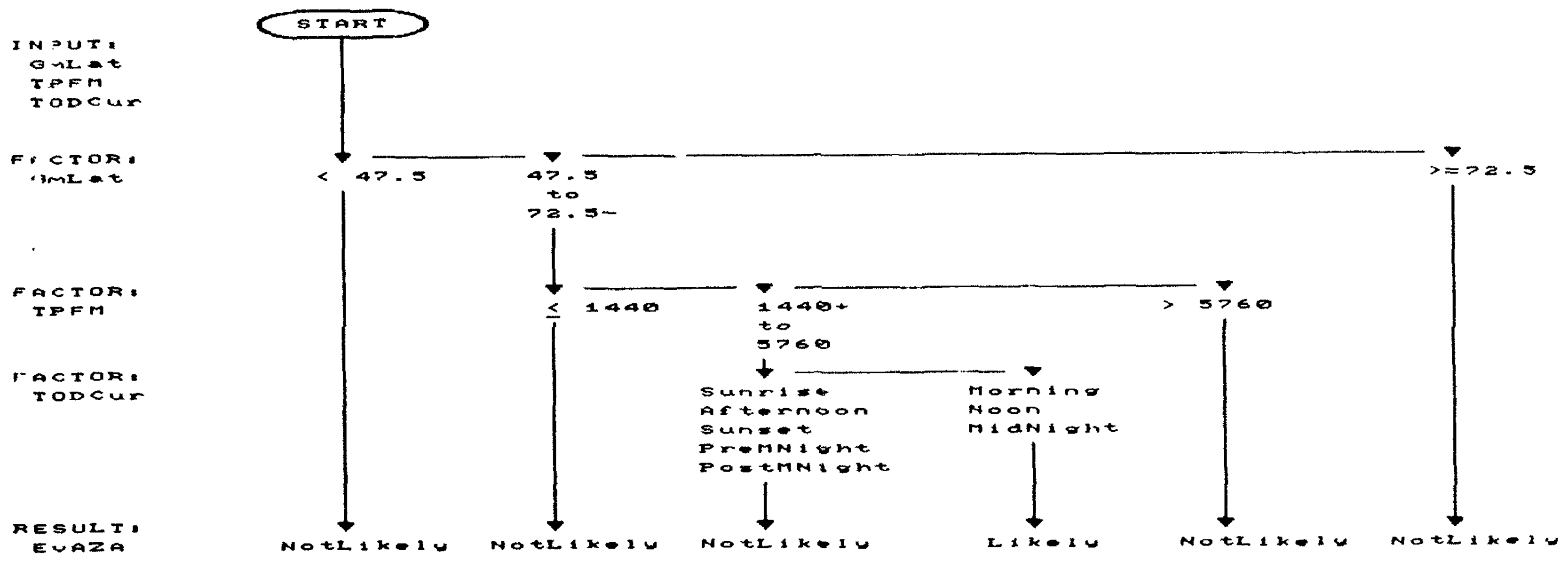
EvAur Submodule



FCEvent

DETERMINE LIKELY EVENTS

EvAZA Submodule



4.3.16 SUDDEN IONOSPHERIC DISTURBANCE (SID) RULESET (FCSID.kbm)

4.3.16.1 Module Description (15 Rules)

(1) Developers - R.B. Rose. Edit and FC ver - D.R. Lambert.

(2) Date Created - 15 May 1989.

(3) Function - The SID rule set was designed to estimate the amount of HF spectrum that is lost after the onset of a solar flare. Sudden Ionospheric Disturbance (SID) effects are caused by direct X-ray radiation from a flare. They occur only in the sunlit hemisphere, are greater the higher the sun is in the sky, and diminish as latitude increases. The onset of SID effects is immediate, and their exponential decay with time follows that of the flare. While most flares are over in an hour, a very large flare can take 4-6 hours for effects to subside.

The characteristics of SID effects are a sudden abrupt loss of signal, followed by a gradual recovery starting at the higher frequencies and migrating to lower frequencies. Signal loss may be expressed as an increase in the Lowest Usable Frequency (LUF). The amount the LUF rises is directly proportional to the magnitude of the solar X-ray burst.

The SID Module uses the path length and the current flare size, which is a function of Time Past Flare (TPF), to estimate the amount of HF spectrum that is lost. SID impact is greater the longer the signal is in the ionosphere, which in turn depends on circuit path length.

Flare size (i.e., the 1-8 angstrom X-ray flux) indicates the amount of HF absorption during a SID. Flare size data is obtained from the GOES weather satellites in the form of continuous, realtime 1-8 angstrom X-ray flux measurements. It is available in reports published by the Space Environmental Support Center, Boulder, CO. The reports express flare size in terms of flare class (M1 to >X5), based on the following criteria:

```
Very_Large = Greater than X5 (0.5 ergs)
Large      = X1 to X5 (0.1 - 0.5 ergs)
Moderate   = M5 to X1 (0.05-0.1 ergs)
Small      = M1 to M5 (0.01 -0.05 ergs)
```

The DIAS SID Module tracks the time after the flare peak and provides updated estimates based on a new NOSC SID model. This model, which gives flare decay as a function of initial flare size, was developed in early 1990, based on 237 solar flares measured between 1 January and 10 March 1989. It assumes an almost instantaneous rise to peak value and an

exponential decay to pre-event values. The duration of this recovery is dependent on the size of the X-ray burst. Nominal outage times are

SID (X-RAY) EVENT DURATION

SID (X-RAY) Size	DURATION Mean
Very_Large	- 6 hours and 5 minutes
Large	- 3 hours and 10 minutes
Moderate	- 2 hours and 30 minutes
Small	- 1 hours and 45 minutes

The nominal X-ray SID duration is 5 hours, and may be as long as 12 hours (3 standard deviations above this value), or shorter than 1 hour for impulsive flares. The maximum impact on HF circuits is at mid-path noon.

(4) Called by Subroutine, Function, or Knowledgebase - 2FCSID.kbm.

(5) Parameters Passed (Inputs) - Sudden Ionospheric Disturbance at High Latitudes (**HiLatSID**, values: Likely, NotLikely), Distance in km (**Dis**, numeric values 0-20016), Current Flare Size (**FlrSzCur**, values: Nil, Small, Med, Large, Very_Large).

(6) Parameters Returned (Output) - Circuit Path (**Path**, values: Short, Medium, Long, InputErrDis), Usable Frequencies Above (essentially the Lowest Usable Frequency, LUF) (**UFA**, string values: Normal, 09, 11, 13, 16, 17, 19, 22, 27, BlkOut), Usable Frequencies Above (**UFAbove**, numerical values: 00, 09, 11, 13,..., 32).

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - Path.kbm.

(9) References -

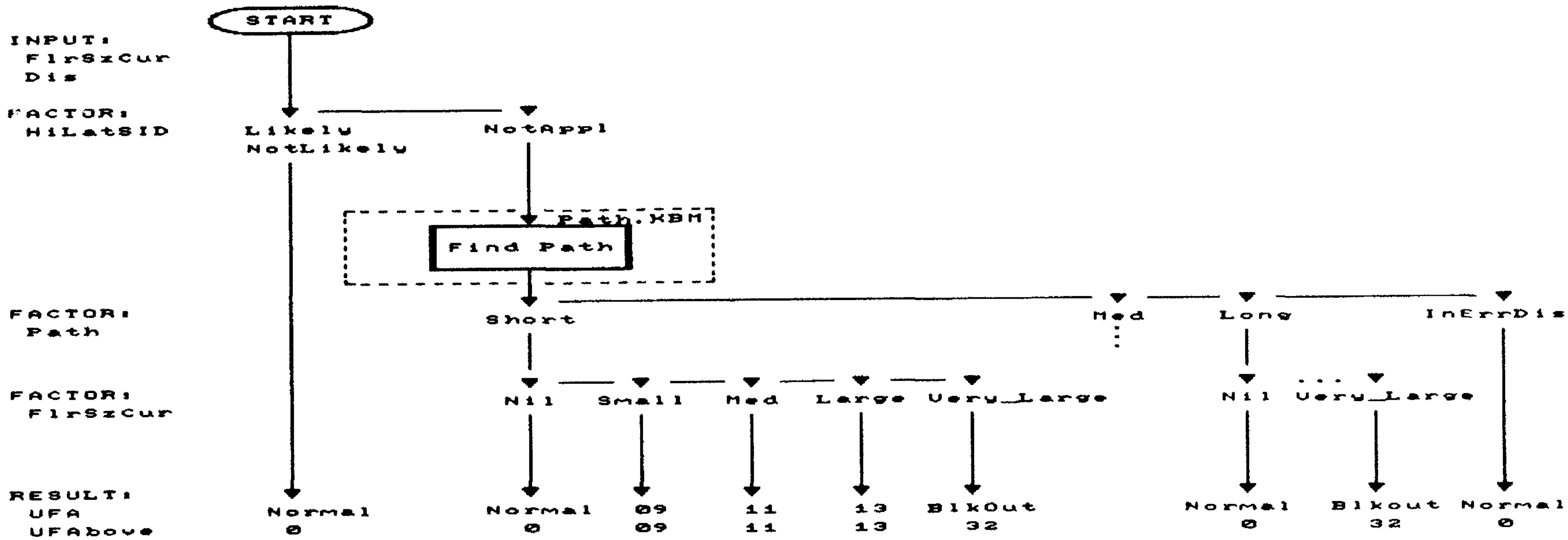
1. Rose, R.B. 1970. "**Short Wave Fade Degradation,**" Naval Weapons Center Technical Publication TP-4976, September 1970.

2. Rose, R.B., J.R. Hill, and M.P. Bleiweiss. 1974. "**Sudden Ionospheric Disturbance Grid (SIDGRID),**" Naval Electronic Laboratory Center Technical Publication TR 1938, 15 December 1974.

(10) Change History - Original Version 15 May 1989; FC conversion 21 December 1989.

4.3.16.2 - Flow Diagrams for FCSID Module - 2 pages

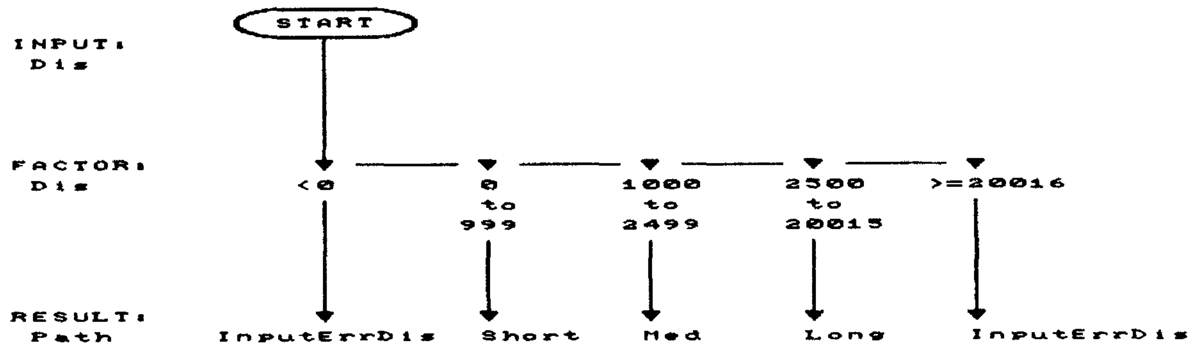
FCSID Module
SUDDEN IONOSPHERIC DISTURBANCE EFFECTS



FCSID

SUDDEN IONOSPHERIC DISTURBANCE EFFECTS

Path Submodule



4.3.17 POLAR CAP ABSORPTION RULESET (FCPCA.kbm)

4.3.17.1 Module Description (69 Rules)

(1) Developers - R.B.Rose. Edit and FCL version - D.R.Lambert.

(2) Date Created - 27 August 1989.

(3) Function - A Polar Cap Absorption (PCA) Event is a significant loss of HF signal strength as the signal traverses the polar cap region above 60 degrees north latitude. This disturbance is caused by extreme D-region enhancements when high-energy protons and alpha particles from a solar flare arrive in the earth's polar regions. Typically, these particles are ejected from the flare at about two-thirds the speed of light and arrive 2 to 6 hours later. Whether and when they will reach the earth is determined in part on their speed and direction in space as they leave the sun - a function of the flare's size and its location on the sun. Once in the earth's polar regions, the particles enhance the D-region of the ionosphere, causing a significant loss in HF signal strength.

PCAs are correlated with the solar cycle: near solar maximum there are normally 6-8 events a year; at solar minimum, none. Generally, when a PCA occurs, it begins 1 to 3 hours after the flare and causes a major degradation of HF signals - usually a complete blackout for at least 1-3 days. PCAs affect only signals transiting the polar-cap regions above about 62.5 degrees latitude.

The probability of there being a flare that will cause a PCA increases with the current smoothed Sun Spot number (SSN). Once a flare has occured, the chances that it will cause a PCA depend on the flare's size and the geographical region on the sun where it occurred. If a PCA does occur, its onset time depends primarily upon the flare's solar location.

The FCPCA.kbm Module determines the probability that a particular flare will cause a PCA event. If one is expected, it also determines expected values for (1) onset time after the flare (a function of the flare's solar location), (2) signal loss (a function of operating frequency and current time of day), and (3) duration (a function of the path latitude and longitude).

(4) Called by Subroutine, Function, or Knowledgebase - 2FCPCA.kbm.

(5) Parameters Passed (Inputs) - SunSpot number (**SSN**, values 0-200+), Location of flare on the sun (**FlrLoc**, values: 90E, 75E, 60E, 45E, 30E, 15E, 0, 15W, 30W, 45W, 60W, 75W, 90W),

Operating Frequency (**Fop**, numeric values: 1-27+ MHz), Current Time of Day (**TODCur**, values: Sunrise, Morning, Noon, Afternoon, Sunset, PreMNight, MidNight, PostMNight; converted to **TODPCA**, values: Day, Night), Corrected Geomagnetic Latitude (**GmLat**, values: -90 to 90 degrees), Corrected Geomagnetic Longitude (**GmLon**, values: -180 to 180 degrees).

(6) Parameters Returned (Outputs) - Expected signal Loss from PCA (**PCALoss**, values: DayLoss, NightLoss), Vertical overhead ionospheric absorption at 30 MHz due to PCA (**PCApLoss**, numeric values in dB), Oblique Loss due to PCA (**PCAoLoss**, numeric values in dB), Probability of a PCA (**PCAProb**, values: Nil, 8pct, 16pct, 25pct, 41pct, 50pct, 58pct, 75pct, 100pct), Time (after the flare) that the PCA is expected to begin (**PCAOnset**, in hours, values: 0.3, 0.7, 1.2, 1.6, 2.1, 2.5, 3.0, 3.5, 3.9, 4.3, 4.8, 5.2, 5.7), expected Duration of the PCA (**PCADur**, values: Nil, 05Hrs, 06Hrs, 10Hrs, 18Hrs, 30Hrs, 42Hrs, 45Hrs, 48Hrs, 52Hrs, 54Hrs, 55Hrs, 60Hrs, GT_60Hrs, NotKnown).

(7) Common Block Returned - Global Variables.

(8) Functions and subroutines referenced - PCAProb.kbm, PCAOnset.kbm, PCALoss.kbm, PCADur.kbm, PCADur1.kbm via PCADur.kbm, PCADur2.kbm via PCADur.kbm, PCADur3.kbm via PCADur.kbm, PCADur4.kbm via PCADur.kbm.

(9) References (PCA) -

1. Stonehocker. 1969. "**Ionospheric Forecasting,**" NATO-AGARD Conference Proceedings no.49, pages 9-1 to 9-12, January 1969. (PCA loss and onset)

2. Bennett, S. 1966. "**A Proposal for a Real Time Frequency Forecasting and Management System,**" AVCO Report RAD-B383-425 for NOLC, CORONA, CA, pages 100-110, 4 March 1966. (Day/Night effects).

3. NATO-AGARD, no. 29, AGARD Lecture Series. 1968. "**Radio Wave Propagation,**" page III-43, July 1968. (PCA duration derived from plot. The coordinates are geographic.)

4. McNamara, L., and R. Harrison. 1988. "**Radio Communicator's Guide to the Ionosphere,**" Draft Textbook Publication, Australia, 1988.

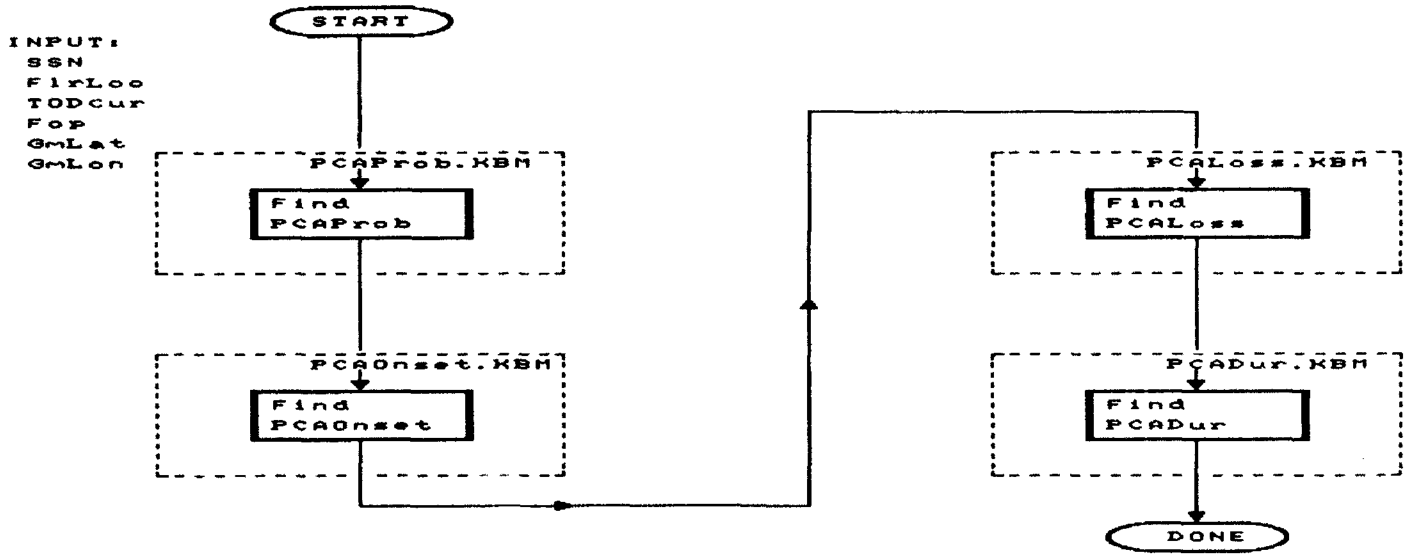
5. Austrailian Electronic Monthly, page 81, August 86. (SSN)

6. Bailey, D. K., Planetary and Space Sciences, 1964. (Day peak of 2.5 dB is the significant PCA level.)

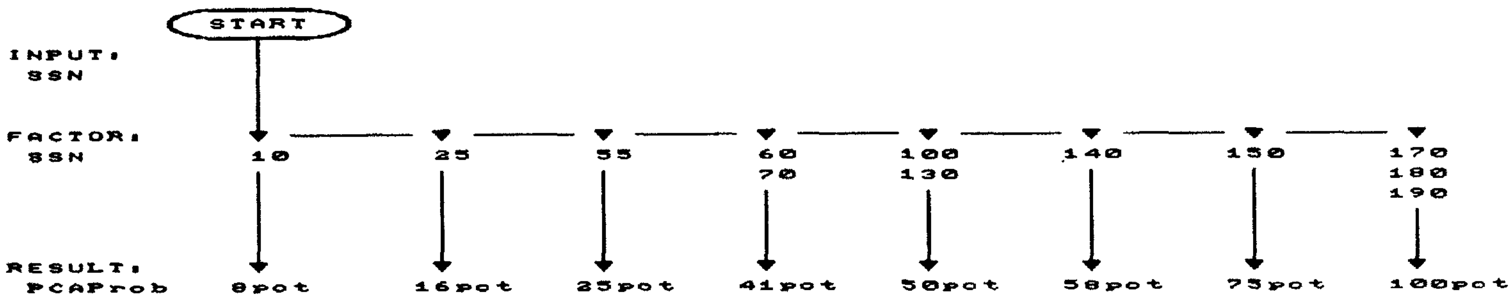
(10) Change History - Original version 27 Aug 89, Revision 1: 9 Jan 90; FC conversion 15 February 1990.

4.3.17.2 - Flow Diagrams for FCPCA Module - 9 pages

FCPCA Module
POLAR CAP ABSORPTION EFFECTS



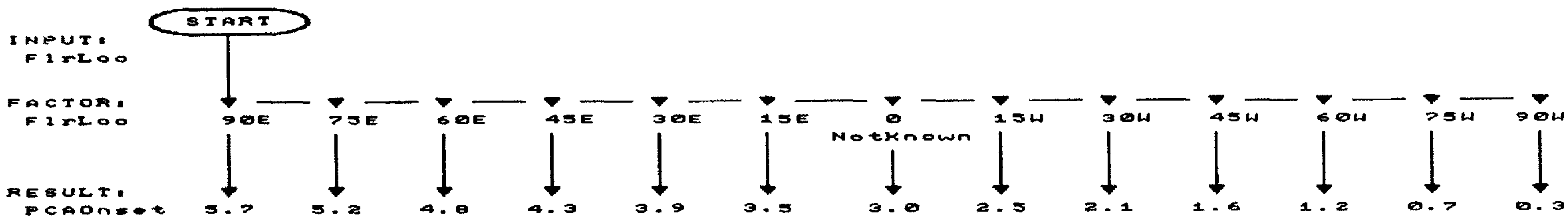
FCPCA
POLAR CAP ABSORPTION EFFECTS
PCAProb Submodule



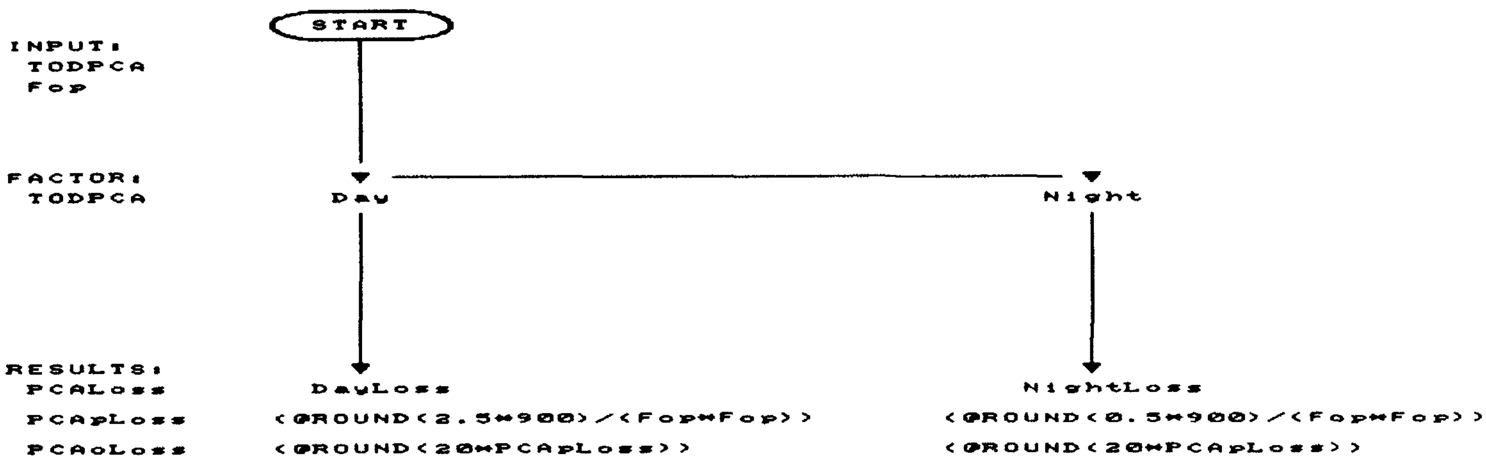
FCPCA

POLAR CAP ABSORPTION EFFECTS

PCAOnset Submodule



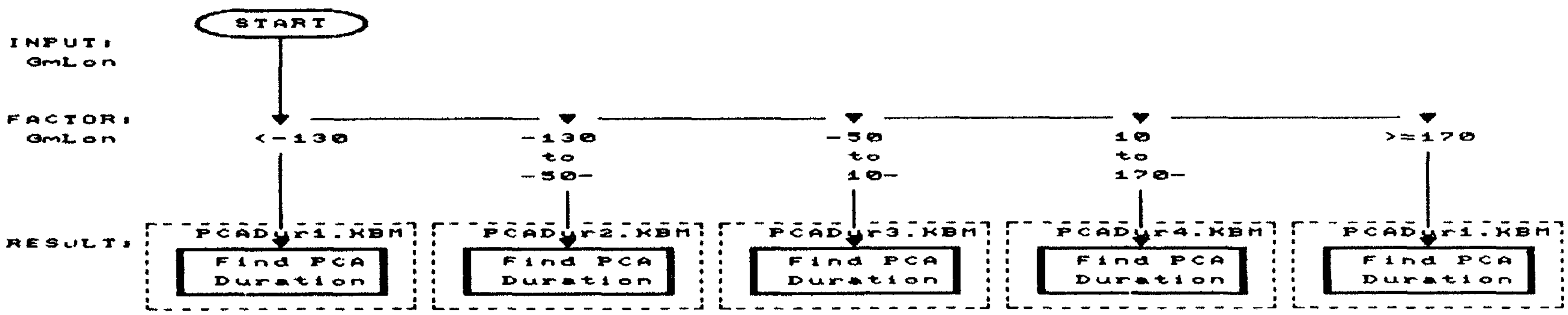
FCPCA
POLAR CAP ABSORPTION EFFECTS
PCALoss Submodule



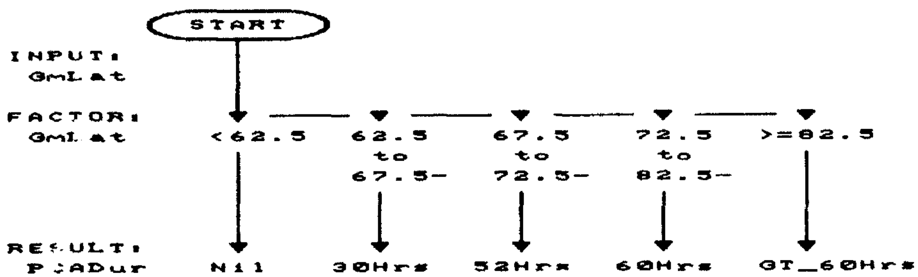
FCPCA

POLAR CAP ABSORPTION EFFECTS

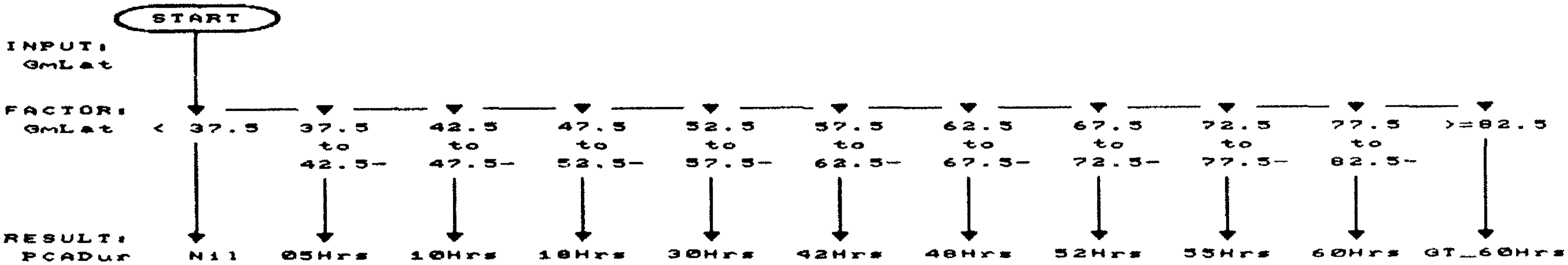
PCADur Submodule



FCPCA
POLAR CAP ABSORPTION EFFECTS
PCADur1 Submodule

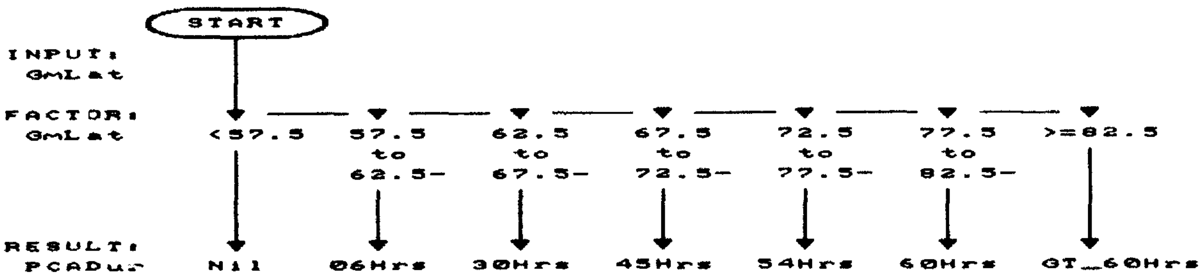


FCPCA
POLAR CAP ABSORPTION EFFECTS
PCADur2 Submodule



FCPCA

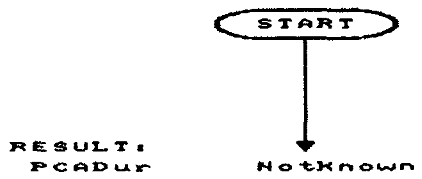
POLAR CAP ABSORPTION EFFECTS
PCADur3 Submodule



FCPCA

POLAR CAP ABSORPTION EFFECTS

PCADur4 Submodule



4.3.18 POLAR CAP ABSORPTION IN PROGRESS RULESET (FCPCANow.kbm)

4.3.18.1 Module Description (See Section 4.3.17 for rule count.)

(1) Developers - R.B. Rose. Edit and FCL version - D.R. Lambert.

(2) Date Created - 20 Jul 1991.

(3) Function - See Section 4.3.17 for a general discussion of Polar Cap Absorption (PCA) Events.

The FCPCANow.kbm Module determines the PCA-induced signal loss in dB due to a PCA currently ("now") in progress. The current 10-MeV proton flux and the current time of day are used to determine HF absorption. The absorption in dB at the frequency of interest (Af) is then calculated by the formula

Af = (ABSORPTION)*((30*30)/(FOP*FOP)).

PCA duration depends on the path latitude and longitude.

(4) Called by Subroutine, Function, or Knowledgebase - 2FCPCA.kbm.

(5) Parameters Passed (Inputs) - 10-MeV Proton Flux (**TenMeVFlux**, Values: 0 to 1350+), Current Time of Day for PCA determination (**TODPCA**, values: Day, Night), Operating Frequency (**Fop**, numeric values: 1-27+ MHz).

(6) Parameters Returned (Outputs) - Polar Cap Absorption (**PCAAbs**, string values: 0-18), Polar Cap Absorption (**PCAAbsN**, numeric values: 0-18), Polar Cap Absorption (Af) at Fop (**PCAAf**, numeric values 0-100+; calculated from PCAAbsN and Fop at start of AfRange.kbm), the range within which Af falls (**AfRange**, values: InErrPCAAf, LT10dB, 10to30dB, 30to50dB, 50to100dB, GT100dB).

(7) Common Block Returned - Global Variables.

(8) Functions and subroutines referenced - PCAAbs.kbm, AfRange.kbm.

(9) References (PCA) -

1. Kuck, G.A. 1969. "**Proton Events 1967-68**," NATO-AGARD, no.49, pages 9-12, January 1969.

(10) Change History - Original version 20 Jul 91; FC conversion 30 Sep 92.

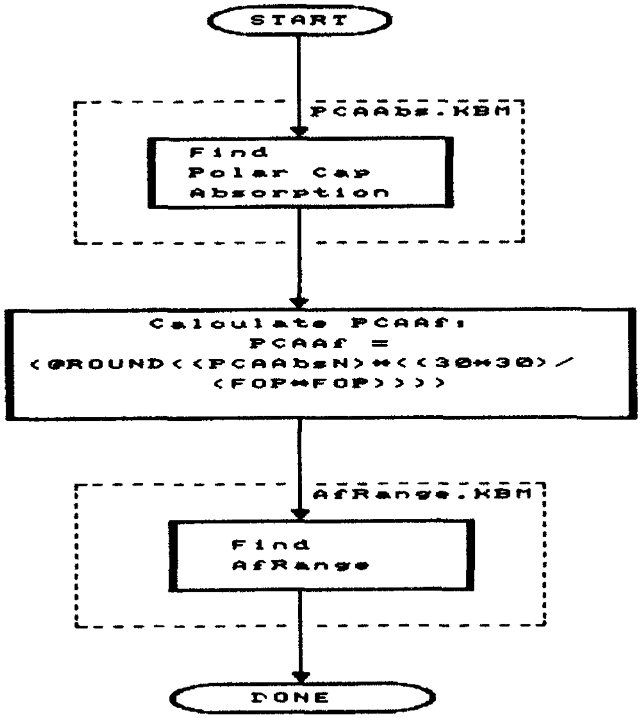
4.3.18.2 - Flow Diagrams for FCPCANow Module - 3 pages

FCPCANow Module

POLAR CAP ABSORTION EFFECTS

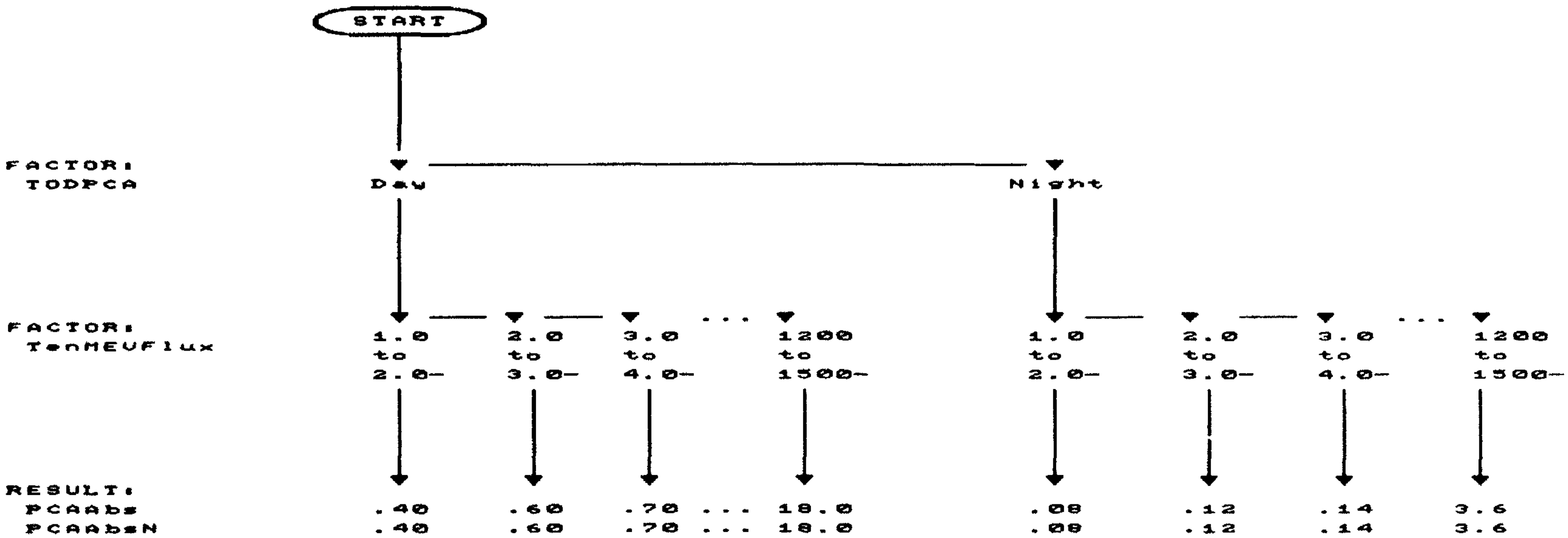
(PCA In Progress)

INPUT:
TODPCA
TenMEUFlux
Fop

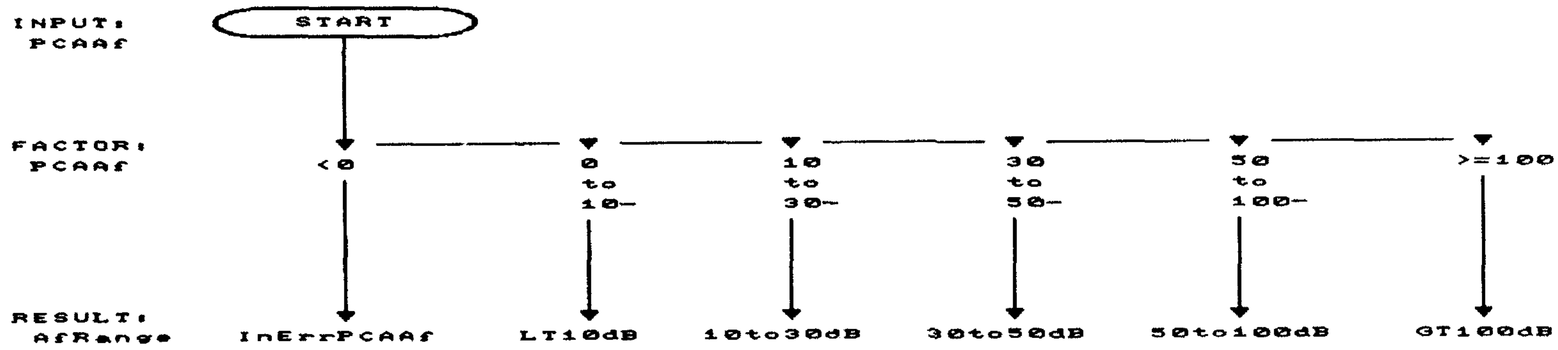


FCPCANow

POLAR CAP ABSORPTION EFFECTS
(PCA IN PROGRESS)
PCAAbs Submodule



FCPCANow
POLAR CAP ABSORPTION EFFECTS
(PCA IN PROGRESS)
AfRange Submodule



4.3.19 HIGH-LATITUDE IONOSPHERIC STORM RULESET (FCIS.kbm)

4.3.19.1 Module Description (121 Rules)

(1) Developers - R.B. Rose. Edit and FCL ver - D.R. Lambert.

(2) Date Created - 15 Feb 1989.

(3) Function - Ionospheric Storms (IS) occur with greatest frequency during periods of high solar activity, as indicated by the current smoothed sunspot number (SSN). They are associated with the Main Phase Onset (MPO), a geomagnetic-field perturbation produced by solar flares, and may occur whenever a large flare-generated plasma cloud of low-energy particles (protons and electrons) is injected into the earth's magnetosphere. Depending on the Universal Time (UT) and the season (i.e., month), these particles can cause an IS to occur when they arrive in the earth's polar regions.

Ionospheric Storms normally can begin 24-36 hours after a flare, starting at higher earth latitudes and migrating to mid- and lower latitudes. Once they begin, their expected duration depends on the level of solar activity. During solar maximum they generally last 2-3 days and tend to be closely correlated with flares occurring within 45 degrees of the solar central meridian. During solar minimum they tend to be more intense, have greater impact, and last longer (4-5 days).

Ionospheric Storms disturb HF signals transiting the polar regions above about 40 degrees north latitude. Their primary effects occur during the day, especially at sunrise. Degradation of all HF signals is characteristic, with periods of complete radio blackout in the late mornings.

Variations in ionospheric Total Electron Count (TEC) also indicate changes in the maximum usable frequency (MUF) during Ionospheric Storms. Significant MUF enhancements occur in the first 10 hours after the flare, with the greatest increase occurring between noon and sunset; thereafter, MUF depressions occur throughout the day for the next several days. Severe depression of the daytime foF2 is characteristic, which results in lower MUFs. During the daytime, the lowest usable frequencies (LUFs) are higher, and anomalous modes of skywave propagation appear. MUFs tend to drop 10-50 percent, and LUFs tend to rise 10-50 percent.

The FCDIAS Ionospheric Storm Module (FCIS.kbm) estimates (1) the probability that an ionospheric storm will occur, (2) the amount of signal loss a circuit experiences ("impact") as a function of latitude, (3) the fraction of the HF spectrum lost during the storm, and (4) the expected storm duration. This module is applicable for control points above 40 degrees north

latitude. The appropriate control point location and corresponding time of day are normally those at the F-region reflection point - the equator-ward one for multiple hop signals. The module is now being modified to enable DIAS to accept multiple control points - currently it uses the same one for all modules.

FCIS.kbm determines the probability of an ionospheric storm by using a recently established empirical relationship between this probability and the Universal Time Coordinated (UTC), the season (i.e., month), and the time past the flare (TPF). This relationship is still tentative. If the IS probability is UNKNOWN, DIAS thenceforth assumes worst case, i.e., that one will occur.

It determines the signal loss (impact) as a function of the local time of day, the latitude, and the geomagnetic index (Kp).

The DIAS TEChange Module determines the amount of ionospheric TEC enhancement or depletion to be expected following the MPO. The change in the TEC depends on the local time at the path F-layer (equator-ward) reflection point and on the time elapsed since the MPO. The module then determines the effect on the MUF by assuming a one-to-one relationship between TEC and ionospheric F-region electron density (FoF2). So, if ionospheric TEC is depleted by 20 percent (i.e., the TEC change is -20 percent), then the electron density FoF2 is reduced by about 20 percent and the MUF is lower.

(4) <u>Called by Subroutine, Function, or Knowledgebase</u> - 2FCIS.kbm.

(5) <u>Parameters Passed (Inputs)</u> - Current Month (**Mo**, numeric values: 1-12), current Universal Time UT (**HourUT**, in hours; converted to **UTQ**, values:00,06,12,18), Current local Time of Day at the HF circuit control point (**TodCur**, values: Sunrise, Morning, Noon, Afternoon, Sunset, PreMNight, MidNight, PostMNight), Time of Day for Ionospheric Storm purposes (TODIS, Values: Morning, Afternoon, Night), Time Past Flare in Minutes (**TPFM**, numeric value), Corrected Geomagnetic Latitude (**GmLat**, values: -90 to 90 degrees), Geomagnetic K-Index (**Kp**, numeric values: 0-9).

(6) <u>Parameters Returned (Outputs)</u> - Probability of Ionospheric Storm (**ISProb**, string values: Low, Med, High), Portion of upper HF spectrum lost due to Ionospheric Storm (**ISLoss**, string values: 0pct to 65pct; and **ISLossN**, numeric values 0 to 65), Impact of Ionospheric Storm (**ISImpact**, string values: NoFreqs_Degraded, Bad_SNR/Min_AZA, Blkouts/Maj_Aur), Duration of Ionospheric Storm (**ISDur**, string values: 0 to 28Hrs: 0to1Hr, 02Hrs, 05Hrs, 07Hrs, 14Hrs, 15Hrs, 18Hrs, 20Hrs,

21Hrs, 28Hrs), Time Past Main Phase Onset (**TPMPO**, string values: zero, 1to3Hrs, 4to6Hrs, 7to9Hrs, 10to12Hrs, 13to15Hrs, 16to21hrs, 22to30Hrs, 31to42Hrs, 43to66Hrs, 67to99hrs), Change in Total ionospheric Electron Content (**TEChange**, string values: -35pct to 45pct).

(7) Common Block Returned - Global Variables.

(8) Functions, Subroutines, and Knowledgebases Referenced - ISProb.kbm, ISLoss.kbm, ISDur.kbm, TEChange.kbm, TPMPO.kbm via TEChange.kbm.

(9) References -

1. Bennett, S. 1966. "**A proposal for a Real Time Frequency Forecasting and Management System**," AVCO Report RAD-B383-425 for NOLC, CORONA, CA, figures 76 and 77 Page 158, 4 March 1966.

2. Rose, R. B. 1971. "**HF Propagation During Ionospheric Storms**," NELC Technical Report TR 1782, figure 3, page 11, 24 August 1971.

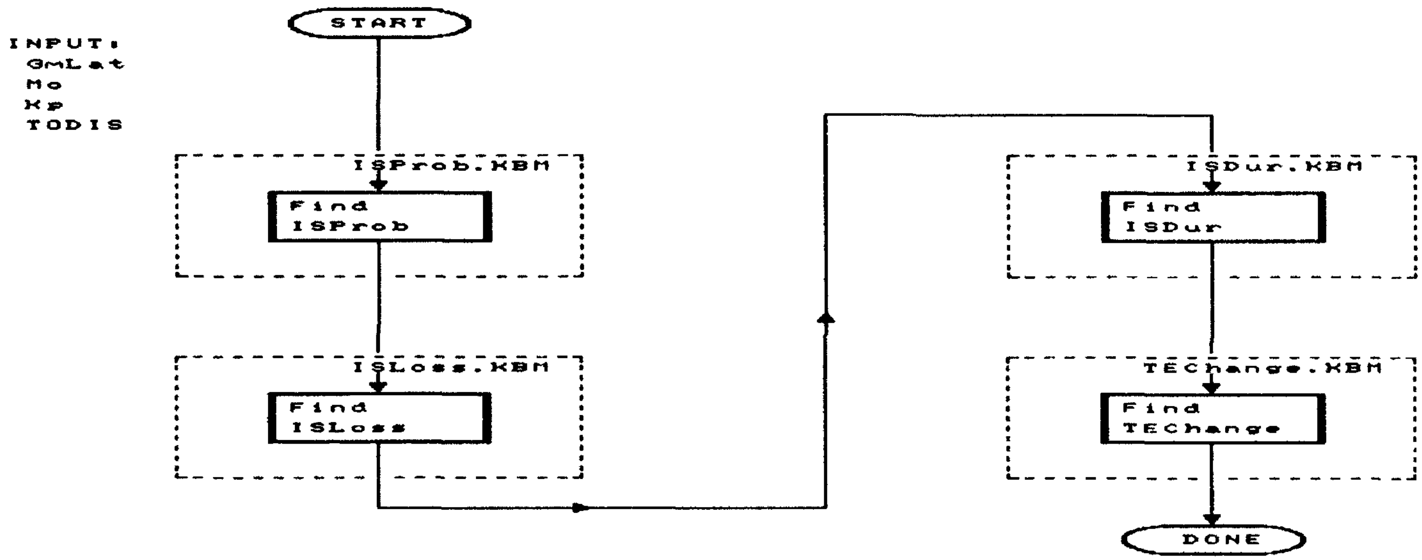
3. McNamara, L., and R. Harrison. 1988. "**Radio Communicator's Guide to the Ionosphere**," figure 8.14, page 86, Draft Textbook, Australian Publication, 1988.

4. Hargreaves, J.K., and F. Bagenal. 1977. "The Behavior of the Electron Content During Ionospheric Storms: A New Method of Presentation and Comments on the Positive Phase," JGR 82, 731-733, 1977. (This journal paper studied TEC variation during 75 ionospheric storms and defined a "typical storm" from MPO to 99 hours. It was the basis for the DIST-TEC development.)

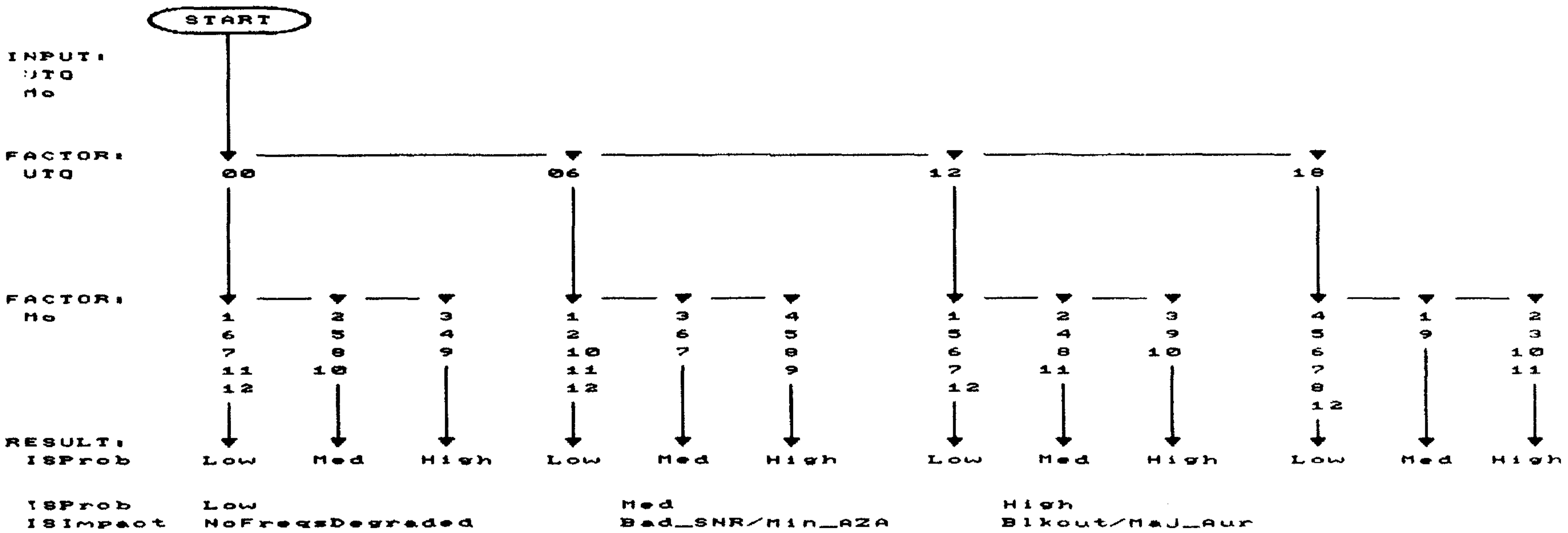
(10) Change History - Revised 11 August 1989; FC conversion 21 December 1989. Original TEChange submodule (DISTTEC) 11 Jun 90; Revised 28 May 91.

4.3.19.2 - Flow Diagrams for FCIS Module - 6 pages

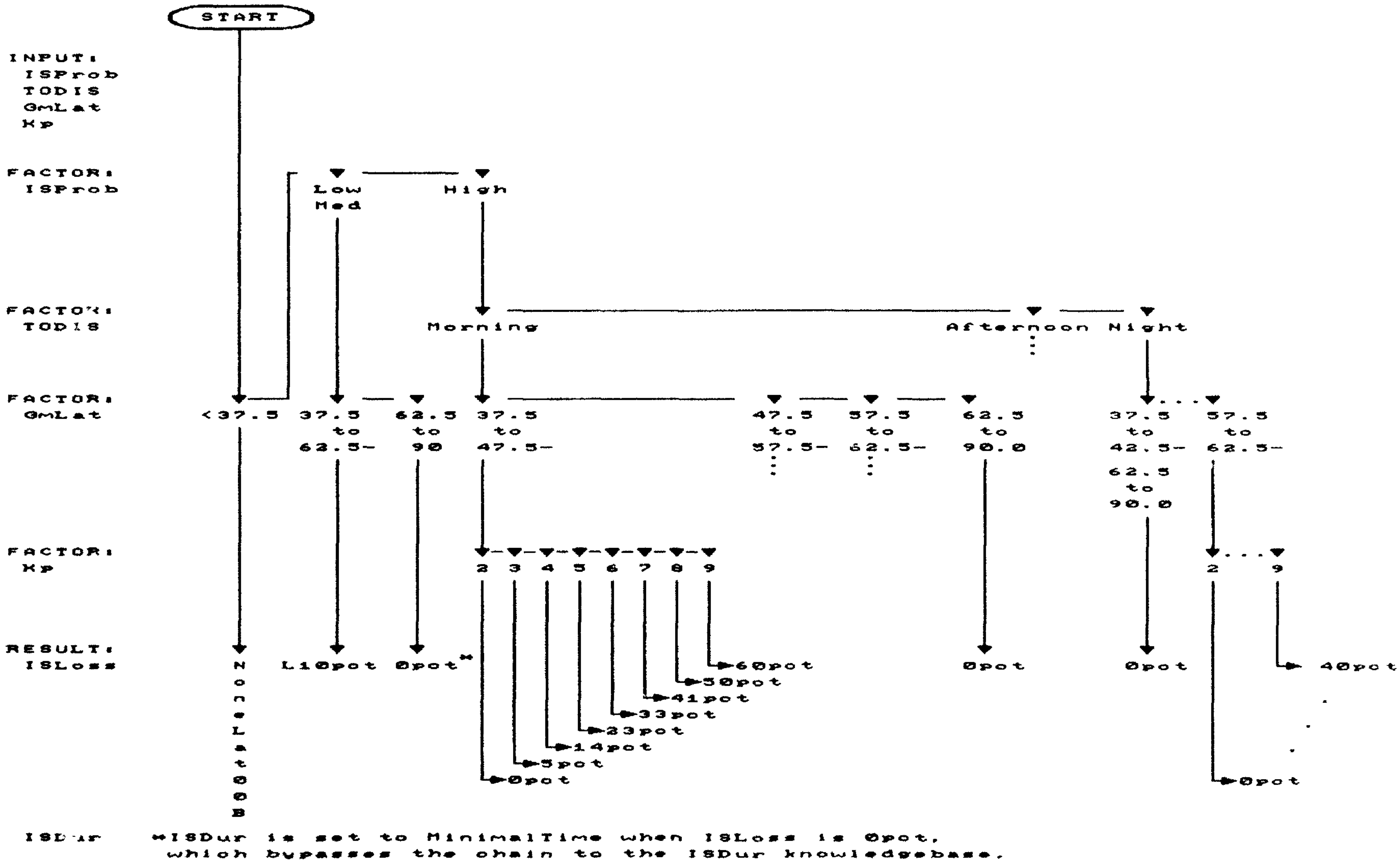
FCIS Module
IONOSPHERIC STORM EFFECTS



FCIS
IONOSPHERIC STORM EFFECTS
ISProb Submodule



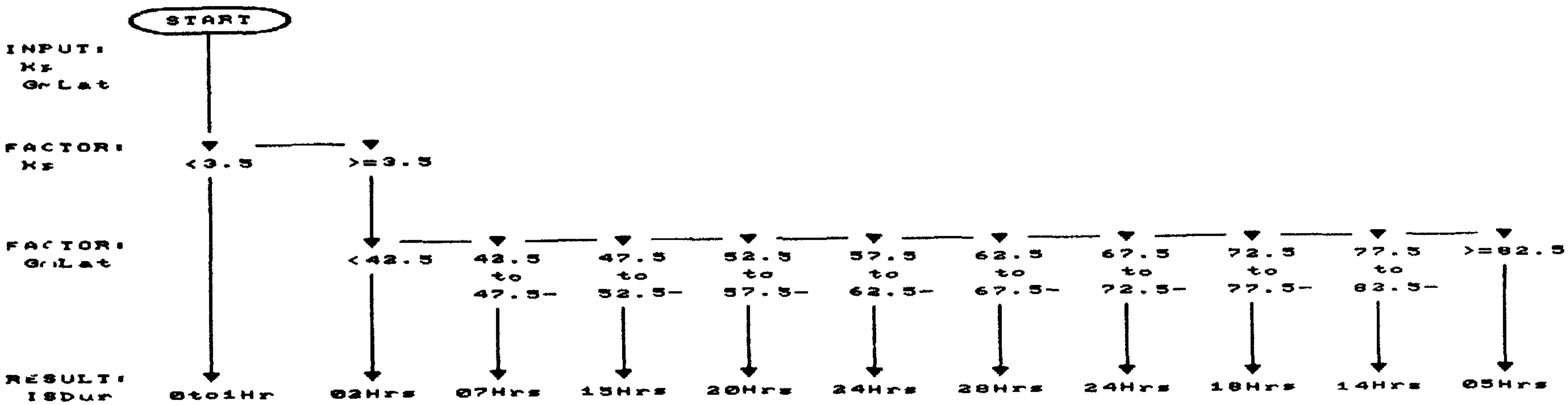
FCIS
IONOSPHERIC STORM EFFECTS
ISLoss Submodule



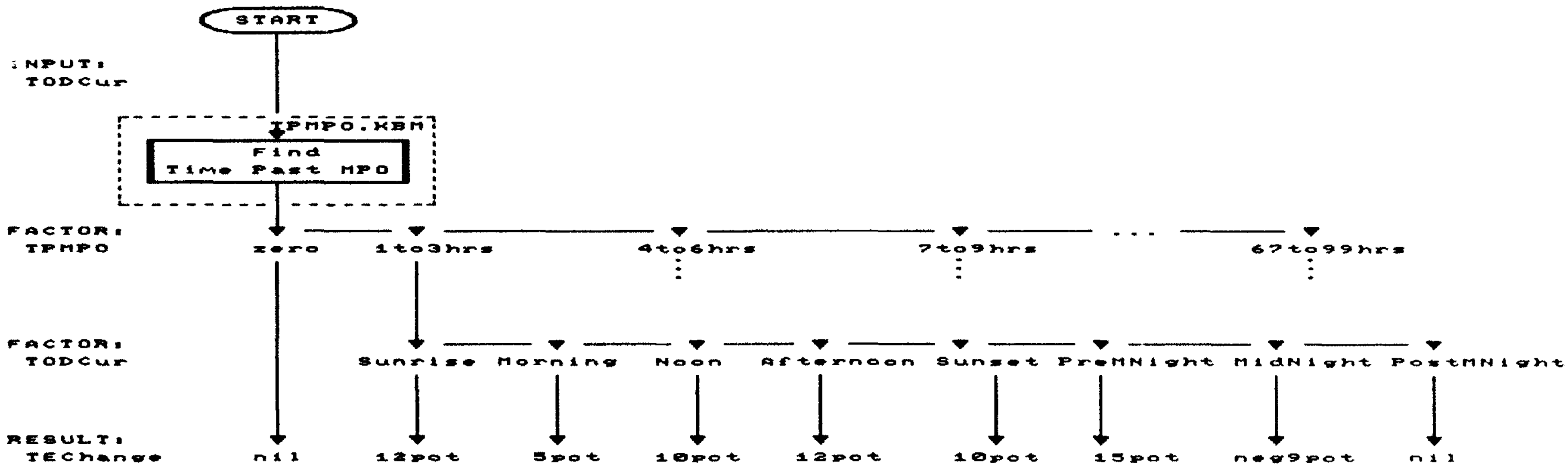
FCIS

IONOSPHERIC STORM EFFECTS

ISDur Submodule



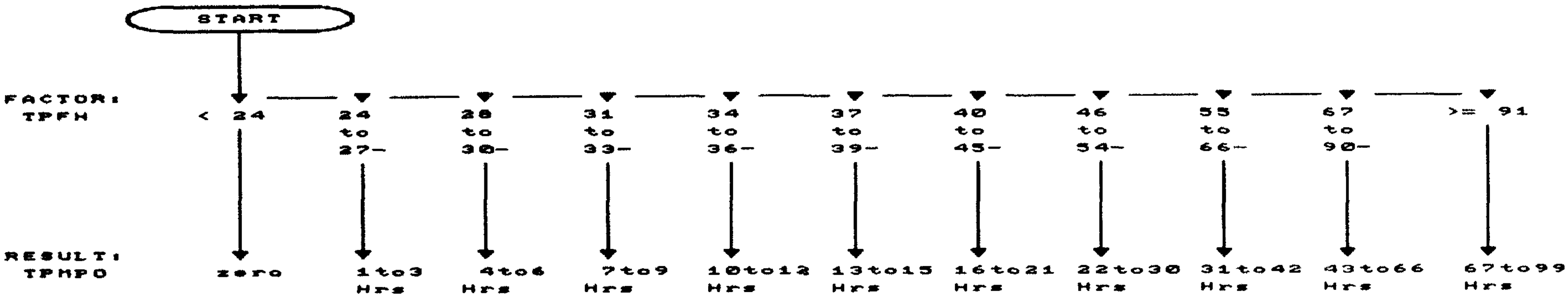
FCIS
IONOSPHERIC STORM EFFECTS
TEChange Submodule



FCIS

IONOSPHERIC STORM EFFECTS

Time Past Main Phase Onset (TPMPO) Submodule



4.3.20 AURORAL E RULESET (FCAur.kbm)

4.3.20.1 Module Description (30 Rules)

(1) Developers - R. B. Rose. Edit and FCL ver - D.R. Lambert.

(2) Date Created - 5 September 1989.

(3) Function - High-latitude ionospheric E-layer effects are caused by auroral ionization particles from a solar flare. As indicated in the PCA Module discussion, high-energy solar particles can enhance the ionosphere's D-region, causing a PCA and attendant loss in HF signal strength. In addition, when the flare is of sufficient magnitude, auroral ionization particles (including 20 keV electrons) may also find their way to the earth's polar regions. When this happens, they may enhance the E-region above some particular latitude and may also cause aurora (Northern Lights).

The FCAur.kbm module is based on published Soviet high-latitude research. It will soon be completely revised based on an NRaD research project now in progress. It is most applicable for HF circuits with E-region control points between 50 and 75 degrees north latitude and between 15 and 75 degrees east longitude in the regions where the auroral zone is dominant. When applicable, Auroral E will be the controlling effect for circuits using frequencies between the Auroral E-region critical frequency (FoE, in MHz) and the maximum usable frequency (MUF).

Given a flare, the FCAur.kbm Module finds FoE at the circuit control point. FoE depends on Kp and the circuit geomagnetic latitude (GmLat). The module then uses FoE to determine the MUF for paths of about 2000 km.

The appropriate Auroral E control point is an E-region passage point, which is determined by the host program and passed to DIAS as an input parameter. DIAS Version 2.0 restricts inputs to a single control point, selected by the host program, for use by all disturbance effects. Future versions will allow a separate control point input for each disturbance effect.

(4) Called by Subroutine, Function, or Knowledgebase - 2FCAur.kbm.

(5) Parameters Passed (Inputs) - Corrected Geomagnetic Latitude (**GmLat**, -90 to 90 degrees), Geomagnetic K index (**Kp**, numeric values: 0-9).

(6) Parameters Returned (Outputs) - High-latitude E-region Critical Frequency (**AurFoE**, string values <none>, 0.1, 1.0, 1.2, 2.0, 2.1, 2.5, 2.9, 3.0, 3.5, 3.7, 4.1, 4.2, 4.6, 4.8,

5.3, 5.5, 5.7, 6.0, InputErrLat, InputErrKp, 8(est), 10(est), 11(est), 9(est), 7(est), 5(est), 3(est)). Note: Values marked (est) were "guesses" provided by Dr. Hunsucker.

(7) <u>Common Block Returned</u> - Global Variables.

(8) <u>Functions and Subroutines Referenced</u> - None.

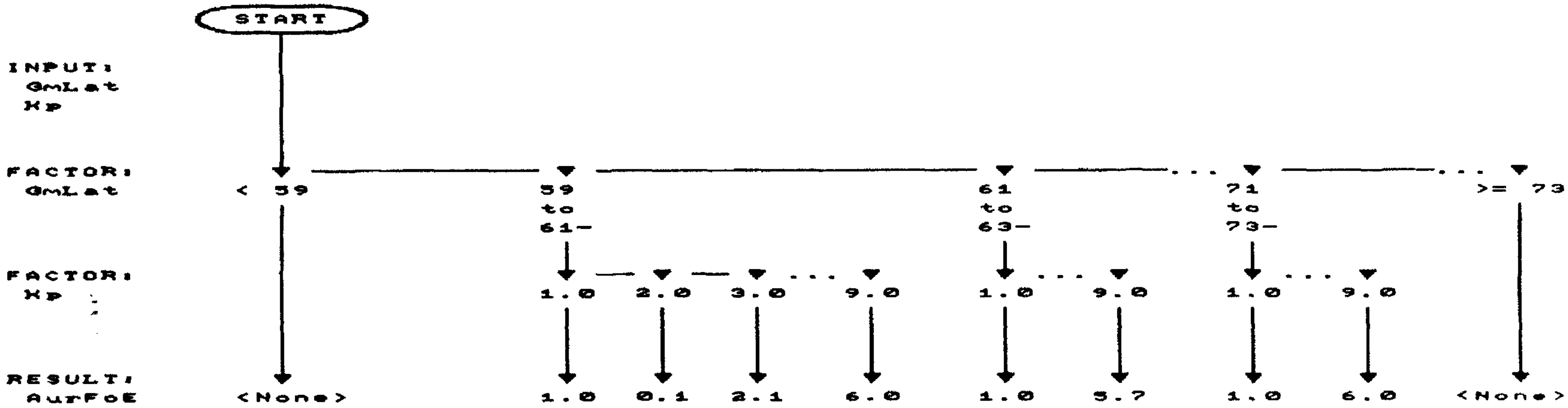
(9) <u>References</u> -

1. Besprozvannaya, A.S., A.V. Shirochkov, T.I. Shchuka. 1981. **"The Dynamics of the High Latitude Ionospheric E-Region,"** Journal of Atmospheric and Terrestrial Physics, vol. 42, pages 115-123, Arctic and Antarctic Research Institute, Leningrad, USSR, Feb 1981.

(10) <u>Change History</u> - Original Version 5 September 1989; FC conversion 21 December 1989; rev. 1990; rev. 5 Jun 91.

4.3.20.2 - Flow Diagram for FCAur Module - 1 page

FCAUR Module
AURORAL E EFFECTS



4.3.21 (Long Path) AURORAL ZONE ABSORPTION RULESET (FCAZA.kbm)

4.3.21.1 Module Description (444 Rules)

(1) <u>Developers</u> - R.B. Rose. Edit and FCL ver - D.R. Lambert.

(2) <u>Date Created</u> - 19 March 1990.

(3) <u>Function</u> - Auroral Zone Absorption (AZA), like Ionospheric Storms, is caused by low-energy particle precipitation from a solar flare and occurs during geomagnetic disturbances. AZA normally begins 24-36 hours after the flare and lasts 1-4 days, peaking in the morning hours. It manifests itself as short-lived transitory periods of absorption, each of which lasts between 30 minutes and 2 hours. AZA has transitory properties similar to those of Sporadic-E and must be handled statistically.

AZA absorbs HF signals transiting the auroral oval, thereby causing signal loss and degrading them. The absorbing region (which is easily located with PROPHET) is centered on the statistical auroral oval zone with a spread of approximately 8 degrees in latitude. The amount of absorption, and therefore the amount of signal degradation, is dependent on (1) the solar cycle, (2) auroral geomagnetic activity, (3) the Auroral Zone Absorption index (Ka), (4) geomagnetic local time (GLT), (5) the frequency of operation, and (6) the circuit control point location. Absorption is greatest in the auroral morning-side sectors and less in the night-side sectors. Ka is a function of geographic location. Auroral geomagnetic activity increases with Kp, a measure of the earth's magnetic field activity obtainable from the SESC data link; Kp is not currently used in this DIAS ruleset. The appropriate control point is the geomagnetic latitude and longitude where the signal passes through (transits) the auroral D-region, i.e., the circuit's D-region passage points.

The DIAS AZA Module (FCAZA.kbm) finds the amount of absorption affecting an HF signal that transits the auroral zone. First, the AZAQ1 submodule determines (1) the range in which the Ap index falls, (2) the percentage of the time riometer absorption measurements exceed 1 dB (Q(1)), and (3) the probability that AZA will occur. Then the AZAAbsL.kbm or AZAAbsH.kbm submodule determines the amount of oblique HF absorption on transauroral HF circuits, applying a low or high sunspot factor (SSN), respectively, and taking into consideration the influence of Ka. Ka, the AZA absorption index, is set by the Ka submodule as a function of geographic (not geomagnetic) latitude and longitude.

(4) <u>Called by Subroutine, Function, or Knowledgebase</u> - 2FCAZA.kbm.

(5) Parameters Passed (Inputs) - SunSpot number (**SSN**, values 0-200+), Operating Frequency (**Fop**, values: 1-27+ MHz), Geographic Latitude (**GgLat**, values -90 to 90 degrees), Geographic Longitude (**GgLon**, values: -180 to 180 degrees), Corrected Geomagnetic Latitude (**GmLat**, values: -90 to 90 degrees), Corrected Geomagnetic Longitude (**GmLon**, values: -180 to 180 degrees), Ap Index (**ApIndex**, numeric values 0-...).

(6) Parameters Returned (Outputs) - AZA Probability (**AZAProb**, values: Nil, High), Auroral Zone Absorption (**AZAAbs**, string values: 0, 1, 2, ... 72, 78, 80), Geomagnetic K-Index (at Anchorage, AK), (**Ka**, string values: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5), Ap Range (**ApRange**, string values: A,B,C,D), Auroral Oval Q1 Index (**AZAQ1**, string values: 0, 5, ..., 30), SSN ranges for AZA purposes (**SSNAZA**, string values: Low, High).

(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Referenced - AZAQ1.kbm, ApRange.kbm via AZAQ1.kbm, 2AZAAbs.kbm, AZAAbsL.kbm via 2AZAAbs.kbm, AZAAbsH.kbm via 2AZAAbs.kbm, Ka.kbm via AZAAbsL.kbm and AZAAbsH.kbm.

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1. Agy, Vaughn. 1970. "**HF Radar and Auroral Absorption**," Radio Science, volume 5, number 11, pages 1317-1324, November 1970.

2. Hargreaves, J.K., M.T. Feeney, H. Ranta, and A. Ranta. 1987. "**On the Prediction of Auroral Radio Absorption on the Equatorial Side of the Absorption Zone**," Journal of Atmospheric an Terrestrial Physics, vol.49, no.3, pages 259-272, 1987.

3. Vladimirov, V. 1969. "**Simplified Method for Calculating Auroral Absorption for Distances of Over 4000 Km**," Telecommunications Journal, vol. 36 -IV, 1969, pages 175-180, figure on page 177.

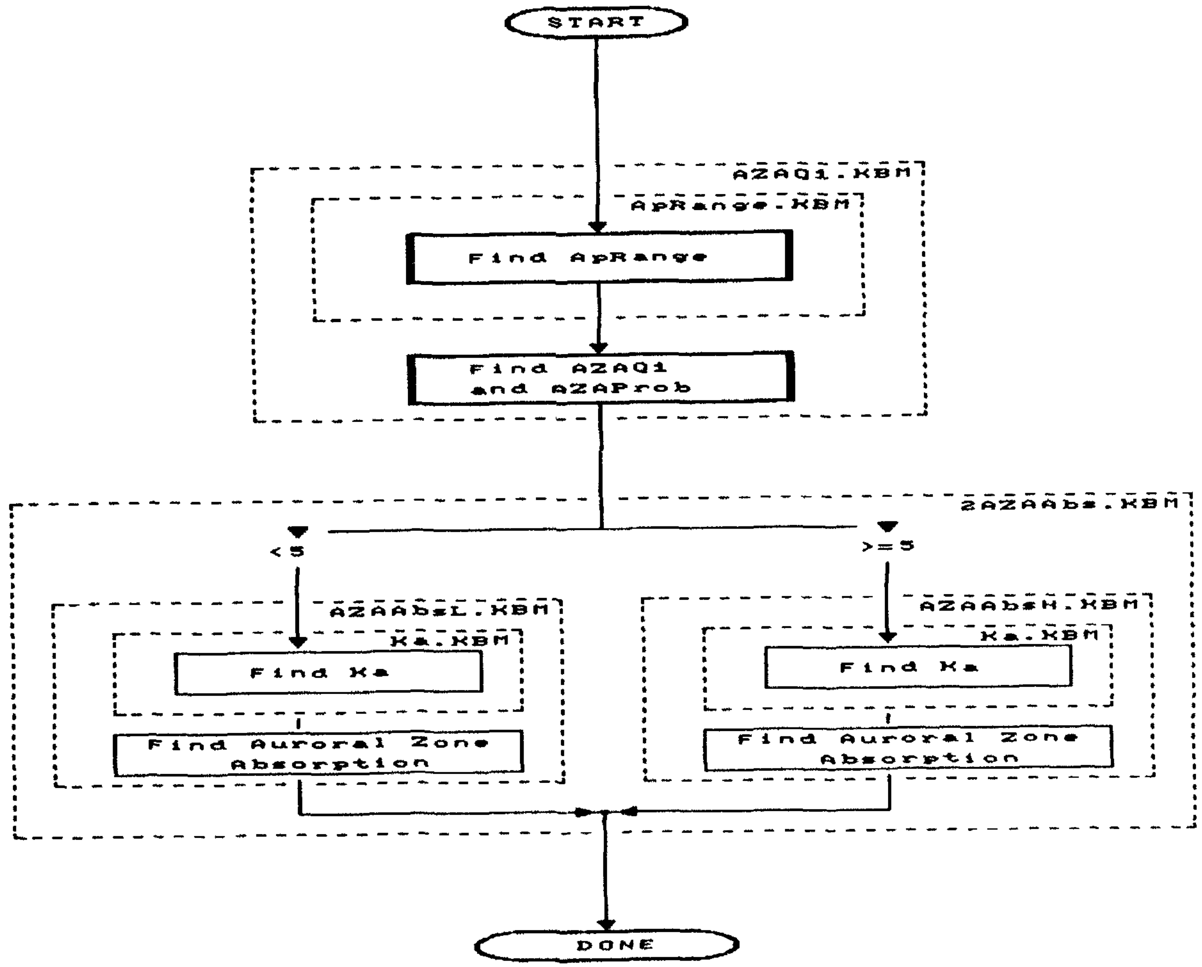
(10) Change History - Original version 3/19/90; FC conversion 29 March 1990.

4.3.21.2 - Flow diagram for FCAZA Module - 6 pages

FCAZA Module
AURORAL ZONE ABSORPTION EFFECTS

INPUT:
SSN
GmLat
GmLon
Fop

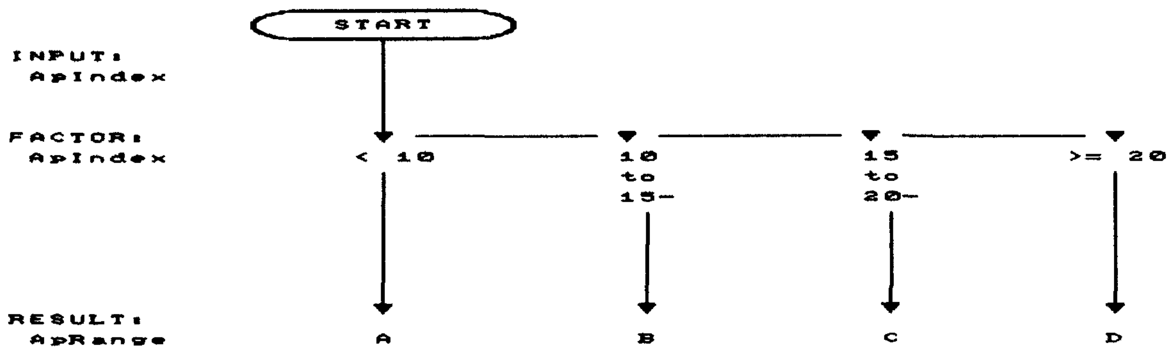
FACTOR:
SSN



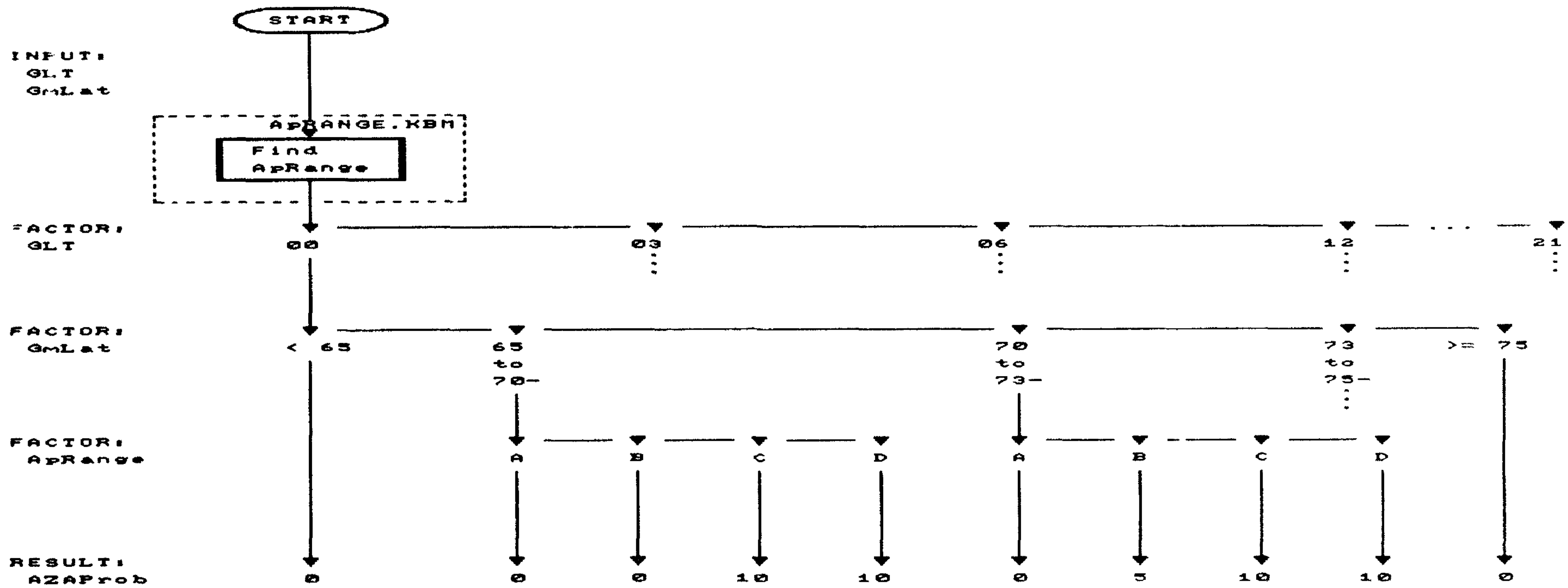
FCAZA

AURORAL ZONE ABSORPTION EFFECTS

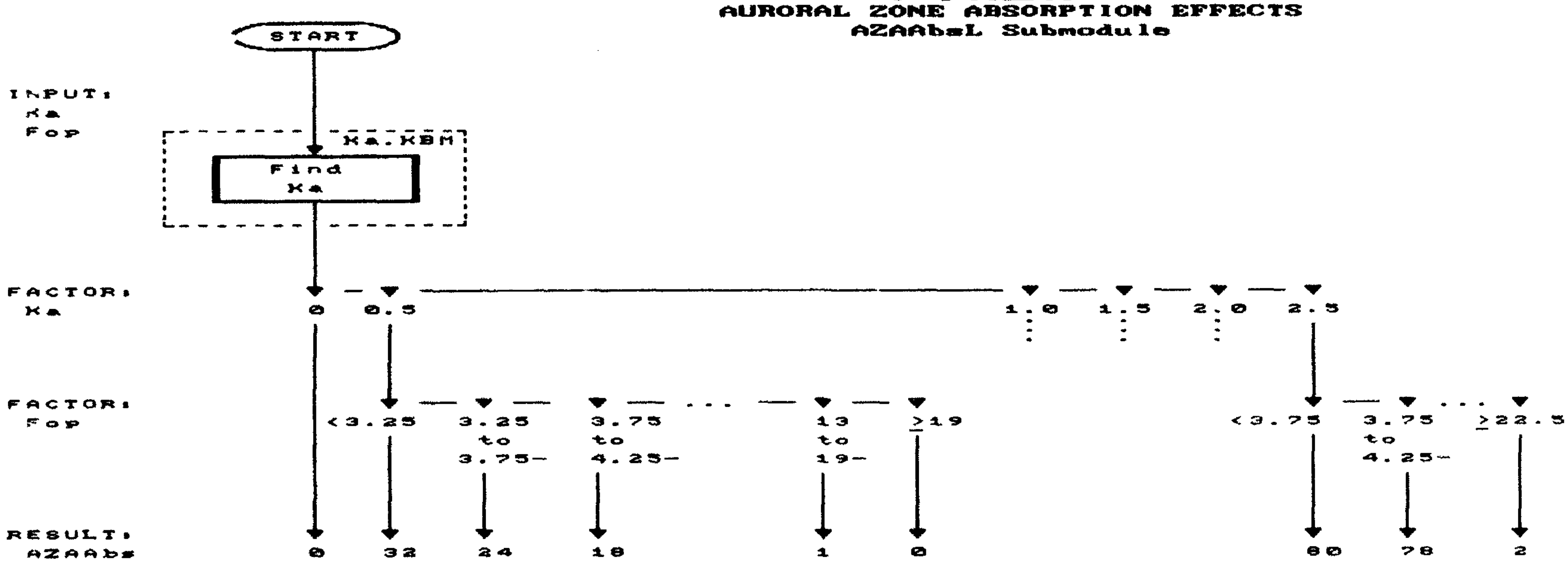
ApRange Submodule



FCAZA
AURORAL ZONE ABSORPTION EFFECTS
AZAQ1 Submodule



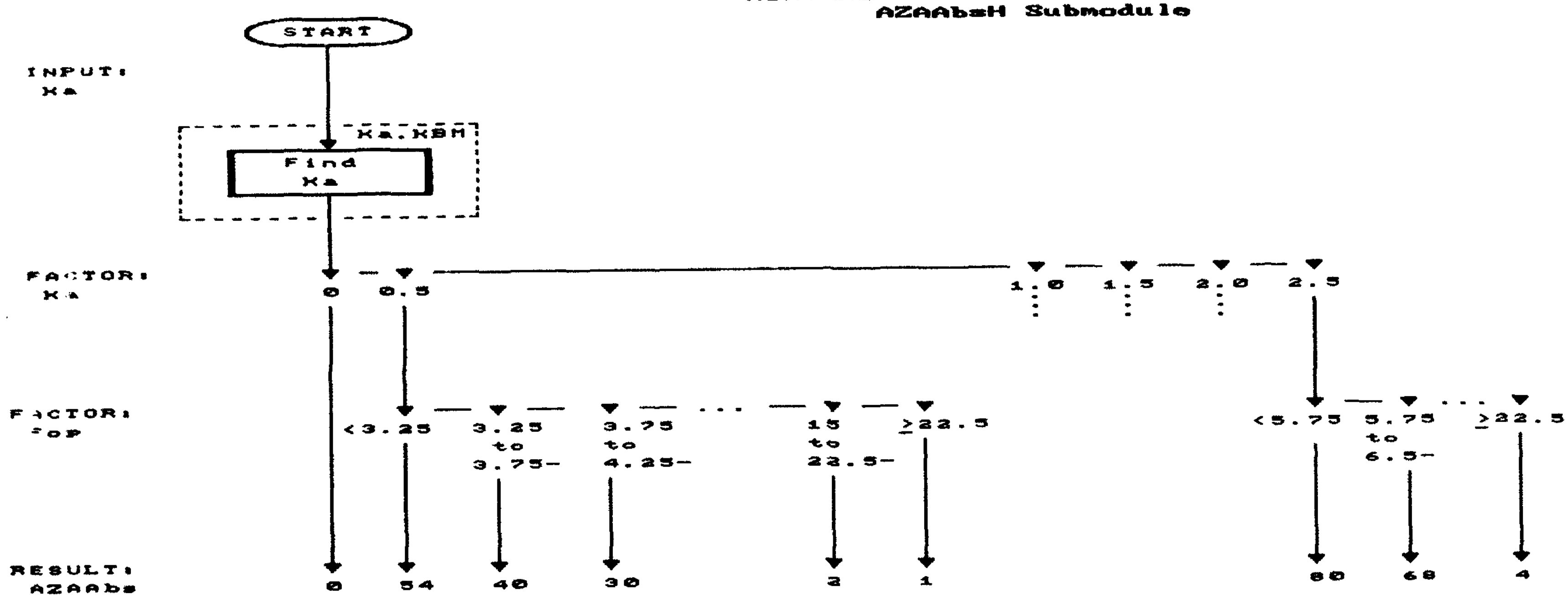
FCAZA
AURORAL ZONE ABSORPTION EFFECTS
AZAAbsL Submodule



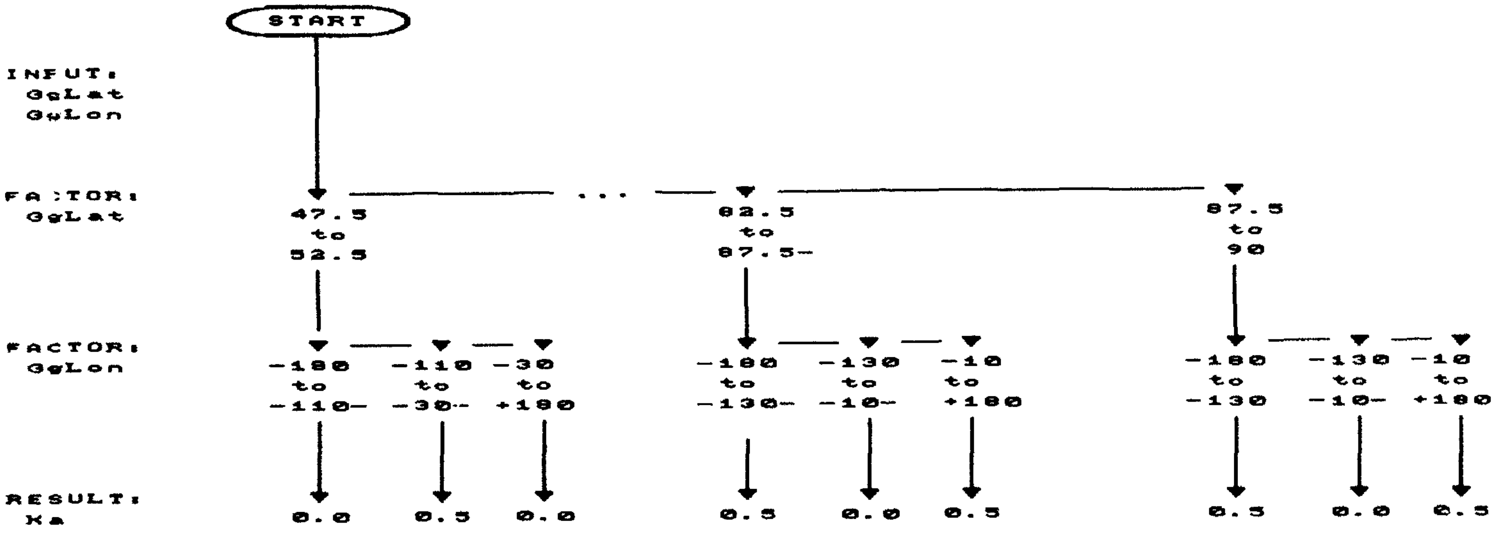
FCAZA

AURORAL ZONE ABSORPTION EFFECTS

AZAAbsH Submodule



FCAZA
AURORAL ZONE ABSORPTION EFFECTS
Ka Submodule



4.3.22 HIGH-LATITUDE TROUGH SIGNAL LOSS MODULE

4.3.22.1 Module Description

(1) Developer - B.J. Satterlee. Edit - D.R. Lambert.

(2) Date Created - 15 March 1990.

(3) Function - This module determines whether any of the F-region control points are located in the High-Latitude Trough region, which is located on the equator-ward edge of the auroral oval. If one is, no signal ray of any frequency is refracted, and the circuit path is effectively terminated.

(4) Called by Subroutine, Function, or Knowledgebase -

(5) Parameters Passed (Inputs) - Circuit control points, equator-ward edge of auroral oval.

(6) Parameters Returned (Outputs) - Signal refracted (yes or no).

(7) Common Block Returned - Global Variables.

(8) Functions and Subroutines Referenced - OVAL Module, High-Latitude Status Module.

(9) References -

1. Hargreaves, Dr. J.K. 1988. "**The High Latitude Ionosphere: Dynamical Aspects and Models,**" NATO-AGARD Lecture Series, Media Effects on Electronic Systems in the High Latitude Region, LS-162, pages 7-6 to 7-7, September 1988.

2. Feldstein, Y.I., and G.V. Starkov. 1970. "**The Auroral Oval and the Boundary of Closed Field Lines of Geomagnetic Field,**" Planetary and Space Sciences, vol. 18, pages 501-508, 1970.

(10) Change History - Original Version 15 may 1990; FC conversion is scheduled for future releases.

4.3.22.2 - Flow Diagram for High-Latitude Trough Module

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* NOSC Technical Note TN 3057, October 1975. NOSC Technical Notes (TNs) are working documents and do not represent an official policy statement of the Naval Ocean Systems Center (NOSC). For further information contact the author.

APPENDIX A

SATELLITE GEOPHYSICAL BROADCASTS AND RECEIVING SYSTEM DATA

SESC SATELLITE BROADCASTS

The following data will appear in the SESC Satellite Broadcasts:

- **GEOMAGNETIC DATA**

Total Field	1-minute averages in gamma
K-Indices	3-hour quasi-logarithmic indices for mid-latitude and pseudo-planetary
A-Indices	Daily index for mid-latitude and pseudo-planetary

- **SOLAR DATA**

Xrays	1-minute averages in w/m2
Xray Background	Daily classification and value
10 cm Flux	Daily value and 90-day mean
Sunspot Number	Daily consensus value
Protons	5-minute averages at >1, >10, >100 Mev
Polar Cap Absorption	15-minute values in db
Total Energy Deposition	Daily average power input in gigawatts
Neutrons	15-minute deviations from preselected level
Proton Fluences	Daily integrated values at >1, >10 Mev

- **IONOSPHERIC DATA**

FOF2 M3000 FMIN	Hourly values in MHz

- **FORECASTS**

Xray Events Protons	Daily probability forecasts for the next 3 days
10 cm Flux A-Indices K-Indices	Predicted daily indices for the next 3 days

- **WARNINGS**

Geomagnetic Proton Solar	Daily descriptions of expected activity levels

- **ALERTS**

Radio Bursts Proton Events Xray Events A-values>20 K-values>4 SSC Stratwarm	Notification of occurrence or expectation of occurrence of events in these categories as required

- **SPECIAL SUPPORT** — Customer support and system status messages issued as required

FORMAT FOR SATELLITE BROADCAST MESSAGES

Line 1. GOES X-RAYS

Doy hhmm SAT #1 an.n SAT #2 an.n BOUTF ggggg GAMMA

Total field

X-ray level as B2.5

X-ray level as B2.5

UT time in hours and minutes

Day of year

LINE 2. FIVE MINUTE DATA/INDICES

Minute
0 1MEV n.nEnn 10MEV n.nEnn 100 MEV n.nEnn PCA n.nDB NEUTRON nnnn

Deviation from preselected level

15 minute values in DB

Numeric values as 3.4 exp 5

Numeric values as 3.4 exp 5

Numeric values as 3.4 exp 5

Minute
1 d00 hh-hn Kn/ggg Gamma BOK nnnn nnnn PL nnnn nnnn 10 cm nnn

10 cm flux value

Planetary K values

Boulder K values

K index and Gamma as K3/28

Last K index, hours as 12-15Z

Current day of year

Minute 2

d-1 BO Annn Knnnn/nnnn PL Annnn Knnnn/nnnn TED nnn

Total energy deposition daily average

Planetary K values

Planetary A values

Boulder K values

Boulder A values

Yesterday day of year

Minute 3

d-1 10cm nnn 90 DAY MEAN nnn SSN nnn X-RAY BGD an.n

Background level as B 2.5

Sunspot number

90 day 10cm mean value

10 cm value

Yesterday day of year

Minute 4

d-1 GOES n (Wnnn) FLUENCE 1 MEV n.nEn 10 MEV n.nEn

Numeric values as 3.4 exp 5

Numeric value as 3.4 exp 5

Longitude

GOES (number)

Yesterday day of year

LINE 3. 24 HOURLY IONOSPHERIC PARAMETERS FROM A MAXIMUM OF 5 SENSORS.
THE SENSORS CAN BE CHOSEN FROM FOF2, M3000, FOES, FMIN AND TOTAL ELECTRON CONTENT (TEC)
AT PRESENT ONLY VANDENBERG FOF2 AND BOULDER TEC ARE ACTIVE.

Minute
0 STA PARM DOY 00 ##.# ##.# ##.# ##.# ##.# ##.# ##.# ##.#

Values (as 08.5)

Hour Start Of Data (Minute 0 Hour 00, Minute 1 Hour 08, Minute 2 Hour 16).

Day Of Year

Parameter

Station

The message will always contain at least the previous 16 hours.

LINE 4. FORECASTS AND WARNINGS each 5 minutes.

Minute
0 Mnn/nn/nn Xnn/nn/nn Pnn/nn/nn 10Cm nnn/nnn/nnn

10 cm Forecast next 3 days

Proton Forecast next 3 days

X Flares Forecast next 3 days

M Flares Forecast next 3 days

Minute
1 AF nnn/nnn/nnn AP nnn/nnn/nnn K kkkkk kkkkk kkkkk

45 hour K Forecast starting at 1800 UT

AP Forecast next 3 days

AF Forecast next 3 days

Minute
2 MAG WWWW....(may put in 60 w's total)

Magnetic Warning or Nil as: MAG-GEOMAGNETIC FIELD IS EXPECTED TO BE ACTIVE.

Minute
3 PRO WWWW....(may put in 60 w's total)

Proton warning or NIL as: PRO-SUSPECTED PROTON FLARE X4/3B S18W40 23/0433Z.

Minute
4 SOL WWWW....(may put in 60 w's total)

Solar Activity Warning or Nil as: SOL-FLARE SOLAR ACTIVITY IS EXPECTED TO BE HIGH.

LINE 5. ALERTS

Line 5 contains the alerts. There are a maximun of ten concurrent alerts and they will be repeated as often as possible; for example if only one alert is active it will be transmitted every minute, and if three are active each will be transmitted once each three minutes. There is the capabillity for three event "durations" or how long it will remain in the active broadcast queue. Line 5 is unformatted text.

EXAMPLES:

LINE FIVE - ALERTS

1. 245 MHZ RADIO BURST 300 FLUX UNITS 0245Z
2. 245 MHZ RADIO NOISE STORM IN PROGRESS 1233Z
3. TENFLARE 5400 FLUX UNITS 0031Z
4. TYPE II RADIO EMISSION 1129Z
5. TYPE IV RADIO EMISSION 2300Z
6. SUSPECTED PROTON FLARE X4/3B S18W56 1745Z
7. PROTON EVENT 233 PROTONS/CM2/SEC/STER AT >=10MEV 1233Z
8. PROTON EVENT 1221 PROTONS/CM2/SEC/STER AT >=100 MEV 1645Z
9. XRAY EVENT M5/2B S23W09 2349Z
10. A >= 20 EXPECTED 12/0422Z MAR
11. A >= 20 OBSERVED 22 DEC
12. A >= 30 EXPECTED 18/1220Z MAR
13. A >= 30 OBSERVED 07 JAN
14. K=4 OBSERVED 00-03Z 17 MAR
15. K=5 OBSERVED 09-12Z 22 APR
16. K=6 OBSERVED 21-24Z 8 FEB
17. K=5-5 OBSERVED 18-21Z 12 JUL
18. SSC OF 80 GAMMAS OBSERVED 21/1304Z NOV
19. STRATWARM/TUESDAY/STRATWARM EXISTS WARMING CONTINUES.

LINE 6. SPECIAL SUPPORT

Line 6 is the status line and can be changed at will be the forcaster. It is repeated each minute.

C-100 Series Micro Earth Stations for Satellite Data Distribution

CONTEL ASC

Overview. Contel ASC's receive-only C-100 Micro Earth Stations are the world's most popular earth stations for low-speed multipoint distribution of data, text and graphics. These microprocessor-based earth stations feature small antennas (24-inch diameter standard antenna) and low power operation, making private satellite data networks practical and economical. They mount easily on windowsills and rooftops of remote offices and residences to provide continuous direct user access to information without telephone lines. Communication to C-100 Series Micro Earth Stations is distance and usage insensitive, providing significant cost savings over voice-grade leased-line networks

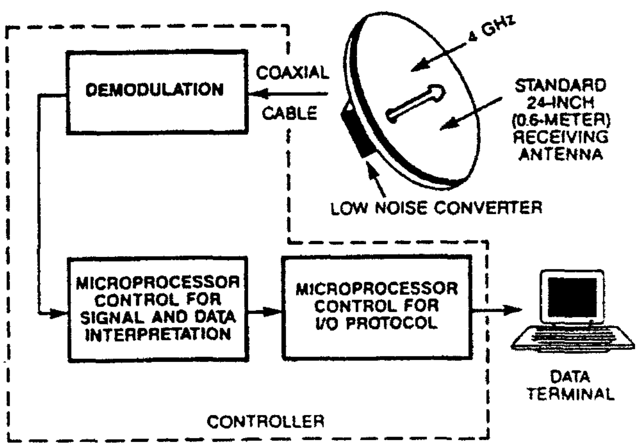
Spread Spectrum Technology. Contel ASC's patented application of spread spectrum transmission technology enables the very small C-100 earth stations to achieve a high level of noise rejection for easy installation in urban areas. Spread spectrum techniques stretch each bit of information, allowing the earth station to pick up a signal despite interference from neighboring satellite and terrestrial signals. Each bit is subdivided into "chips" which follow a unique pattern. The earth station can decipher the pattern even if some of the chips are lost in transmission. The reliability, capability and flexibility of the C-100 Series Micro Earth Stations make them suitable for many types of network applications:

- Intracorporate data distribution
- Market and financial information
- Trading data bases
- News
- Weather information
- Electronic mail
- Digital facsimile transmission

Features:

- Small diameter antenna
- Light weight
- Data rates of 15 cps up to 2400 cps
- Multi-port receiver capability
- Built-in intelligence and diagnostics
- Interference-resistant operation
- Bit error rates better than 1 in 10 million
- No licensing required

C-100 Series Micro Earth Stations consist of a small antenna module connected by standard coaxial cable to a small indoor digital receiver/controller.



The antenna of a C-100 Micro Earth Station collects 4 GHz signals received from the satellite. Microwave electronics in the low noise converter amplify and convert the frequency of incoming signals. The separate micro earth station controller contains circuits for signal demodulation, a microprocessor-based signal and data interpretation function and Input/Output control facilities.

CONTEL ASC

SPECIFICATIONS:

Antenna and Low Noise Converter

- *Antenna Size:*
  0.6m (24 in.) diameter
  0.75m (30 in.) diameter
  1.2m (48 in.) diameter
- *Mounting Area:*
  0.6m antenna, 0.64m (25 in.) diameter circle
  0.75m antenna, 0.8m (32 in.) diameter circle
  1.2m antenna, 1.0m (39 in.) width, 0.9m (35 in. length)
- *Weight (including mounting frame):*
  0.6m antenna: 9kg (20 lbs.)
  0.75m antenna: 11kg (25 lbs.)
  1.2m antenna: 30kg (66 lbs.)
- *Power:*
  20V to 32V (from controller to module)
- *Connection:*
  Coaxial cable (RG59U), 152m (500 ft.) maximum length in-line connector to controller unit.
- *Operating Temperature:*
  −40°C to 60°C
- *Survival Temperature:*
  −50°C to 70°C (power applied)
- *Wind, Operational:*
  100km/hour (62 mph)
- *Wind, Survival:*
  160km/hour (100 mph) gust

Controller (cables not included)

- *Size:*
  445mm (17.6 in.) long × 343mm (13.5 in.) wide × 140mm (5.5 in.) high.
- *Weight:*
  8.6kg (19 lbs.)
- *Operating Temperature:*
  0°C to 50°C
- *Power:*
  115V-120V AC, 60 Hz, 65W (U.S.)
  220V AC, 50 Hz, 65W (International)
- *Power Protection:*
  Non-volatile memory
- *Cable Length Permitted:*
  Up to 15m (50 ft.) for RS-232C interface
  Up to 1.2km (4000 ft.) at 19.2 bps for RS422

I/O Interface

- *Bit Error Rates:*
  Better than 1 in 10 million
- *Output Mechanical Interface:*
  RS-232C
- *Codes:*
  5, 6, 7, 8 bits selectable

I/O Mode: Serial Asynchronous

- *Rates:*
  45, 75, 135, 150, 225, 300, 600, 1200, 2400, 4800, 9600 bps
- *Protocols:*
  Serial async with 1 start and 1, 1½ or 2 stop bits selectable
- *Output:*
  4 channels
- *Output Electrical Interface:*
  RS-232C, 20 mA current loop

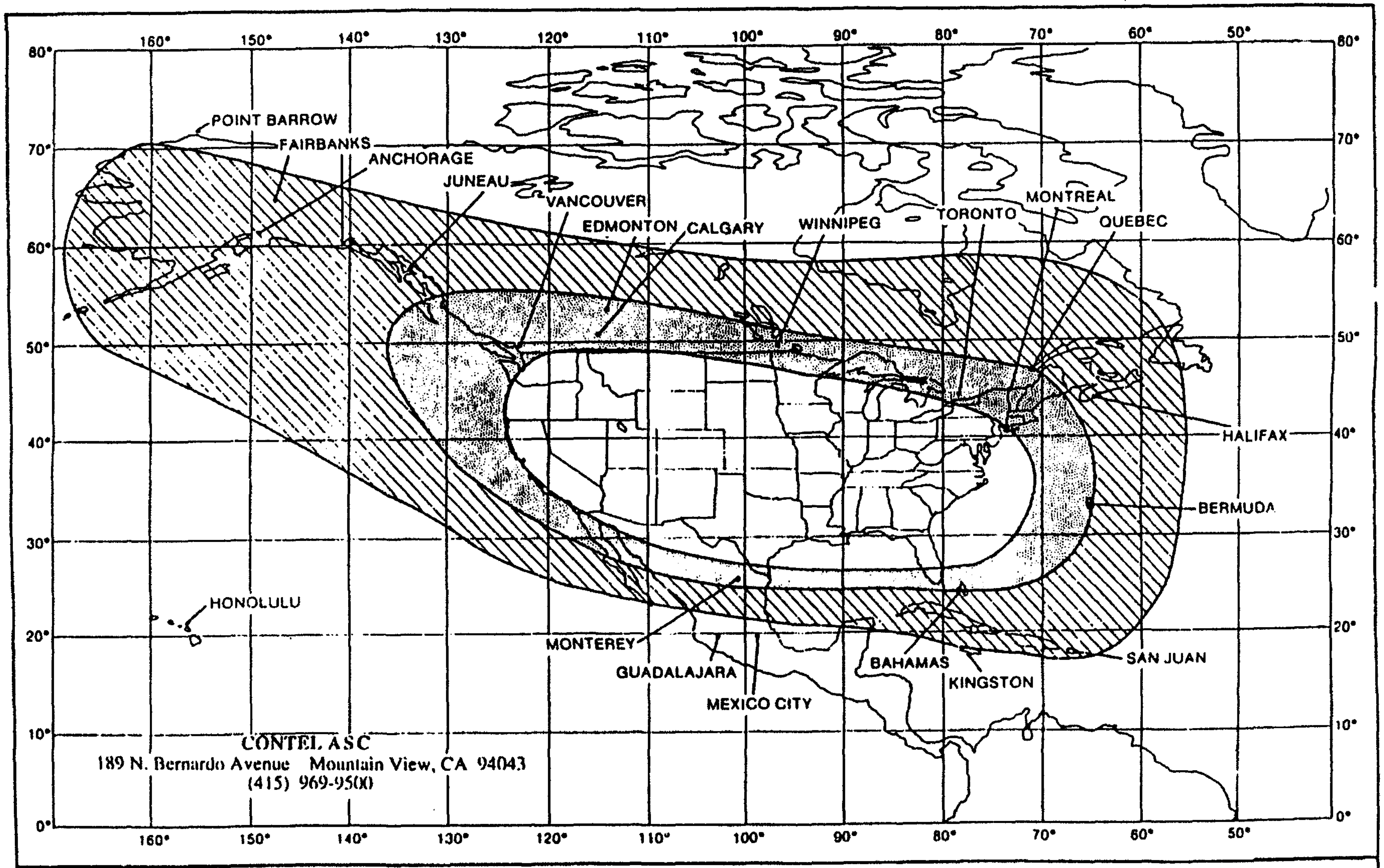
I/O Mode: Serial Asynchronous or Synchronous

- *Rates:*
  300, 600, 1200, 2400, 4800, 9600, 19,200 bps
- *Protocols:*
  Serial async with 1 start and 1, 1½ or 2 stop bits selectable, SDLC bisync
- *Output:*
  4 channels
- *Output Electrical Interface:*
  RS-232C, RS-422

I/O Mode: Intelligent Programmable

- *Rates:*
  300, 600, 1200, 2400, 4800, 9600, 19,200 bps
- *Protocols:*
  Serial async with 1 start and 1, 1½ or 2 stop bits selectable, SDLC bisync
- *Output:*
  2 channels
- *Output Electrical Interface:*
  RS-232C, RS-422

CONTEL ASC ***300 Ferguson Drive, Mountain View, California 94043 (415) 969-9500***



These contours represent the boundries within which the Contel A.S.C. Earth Stations will operate within an error rate of 1 x 10[illegible] or better, with a 3 dB nominal margin to guard against mispointing, rain attenuation, sun noise or equipment degradation. Outside these boundries, the earth station may receive the satellite signal and appear to operate well but the error rate will be higher. The contours have been supplied by Contel A.S.C.'s satellite suppliers.

CONTEL ASC

FOOTPRINT

LEGEND:

- 0.6 Meter Earth Station
- 0.75 Meter Earth Station
- 1.4 Meter Earth Station

EF/IK 7/85

APPENDIX B

FCDIAS RULESET (DECISION TREE) LISTINGS

#0
#FCDIAS

```
    Rule for knowledge base FCDIAS              10:35 am  07/15/1992

    MEMO
 1: SETUP??
 2: └:#FCCONTR??
 3:    └:─────────────────────────────────────── no_data
```

#FCContr

Rule for knowledge base FCContr 10:50 am 07/15/1992

```
MEMO
INIT??
└:#FCHEADER??
  └:HELPDIASB??
    └:#2DATIN??
      └:#FCCOORD??
        └:#FCFLR??
          └:#FCEVENT??
            └:#2FCSID??
              └:#2FCPCA??
                └:#2FCIS??
                  └:#2FCAUR??
                    └:#2FCAZA??
                      └:#FCOUT??
                        └:———————————————————— no_data
```

#FCHeader

Rule for knowledge base FCHeader 10:51 am 07/15/1992

```
    MEMO
 1: DUMMY??
 2: └:──────────────────────────────── no_data
```

#2DatIn

Rule for knowledge base 2DatIn 10:52 am 07/15/1992

```
    MEMO
 1: ENTERDATA??
 2: ├Now:──────────────────────────────────── #FCDatIn
 3: └Later:────────────────────────────────── ˜Return
```

#FCDatIn

Rule for knowledge base FCDatIn 10:53 am 07/15/1992

```
    MEMO
 1: SETFKEY??
 2: └:DATAENTRY??
 3:   └:RESETFKEY??
 4:     └:-------------------------------------------- no_data
```

#FCCoord

Rule for knowledge base FCCoord   10:53 am   07/15/1992

```
     MEMO
 1:  #TPFMCHK??
 2:  └:#GMLATCHK??
 3:    └:#GMLONCHK??
 4:      └:#GGLATCHK??
 5:        └:#GGLONCHK??
 6:          └:#KPCHK??
 7:            └:SYSTIME??
 8:              └:#FCHOUR??
 9:                └:MO??
10:                  └:#FCTOD??
11:                    └:──────────────────────────────── no_data
```

#TPFMChk

Rule for knowledge base TPFMChk 11:23 am 07/15/1992

```
1: TPFM??
2: ├ <-0.00005:────────────────────────────── InErrTPFM
3: └ ≥-0.00005:TPFM??
4:             ├ <20160.:────────────────────── OK
5:             └ ≥20160.:────────────────────── InErrTPFM
```

#GmLatChk

Rule for knowledge base GmLatChk 10:53 am 07/15/1992

```
GMLAT??
├ <-90.:───────────────────────────────────────── InErrGmLat
└ ≥-90.:GMLAT??
              ├ <90.:──────────────────────────── OK
              └ ≥90.:──────────────────────────── InErrGmLat
```

#GmLonChk

Rule for knowledge base GmLonChk   10:53 am 07/15/1992

```
1: GMLON??
2: ├ <-180.:──────────────────────────────────────── InErrGmLon
3: └ ≥-180.:GMLON??
4:                 ├ <180.:───────────────────────── OK
5:                 └ ≥180.:───────────────────────── InErrGmLon
```

#GgLatChk
Rule for knowledge base GgLatChk 10:54 am 07/15/1992

```
1: GGLAT??
2: ├ <-90.:─────────────────────────────── InErrGgLat
3: └ ≥-90.:GGLAT??
4:               ├ <90.:───────────────────────── OK
5:               └ ≥90.:───────────────────────── InErrGgLat
```

#GgLonChk

Rule for knowledge base GgLonChk   10:54 am 07/15/1992

```
1: GGLON??
2: ├ <-180.:──────────────────────────────── InErrGgLon
3: └ ≥-180.:GGLON??
4:                ├ <180.:─────────────────── OK
5:                └ ≥180.:─────────────────── InErrGgLon
```

#KpChk

Rule for knowledge base KpChk 10:54 am 07/15/1992

```
KP??
├ <-0.00005:───────────────────────────── InErrKp
└ ≥-0.00005:KP??
                 ├ <9.99995:────────────── OK
                 └ ≥9.99995:────────────── InErrKp
```

#FCHour

Rule for knowledge base FCHour 10:54 am 07/15/1992

```
HOURUT??
├ <14.5:HOURUT??
│          ├ <7.5:HOURUT??
│          │         ├ <3.5:──────────────────────────── 00
│          │         └ ≥3.5:──────────────────────────── 06
│          └ ≥7.5:──────────────────────────────────── 12
└ ≥14.5:HOURUT??
           ├ <19.5:─────────────────────────────────── 18
           └ ≥19.5:HOURUT??
                      ├ <22.5:──────────────────────── 21
                      └ ≥22.5:──────────────────────── 00
```

#FCTOD

Rule for knowledge base FCTOD 8:39 am 07/07/1992

```
1: TODCUR??
2: └:#TODPOLAR??
3:   └:——————————————————————————————————— no_data
```

#TODPolar

Rule for knowledge base TODPolar 10:55 am 07/15/1992

```
MO??
├ <9.:MO??
│       ├ <4.:MO??
│       │     ├ <3.:GGLAT??
│       │     │     ├ <77.5:MO??
│       │     │     │       ├ <2.:GGLAT??
│       │     │     │       │     ├ <67.5:────────── NotAppl
│       │     │     │       │     └ ≥67.5:────────── 24HrNight
│       │     │     │       └ ≥2.:────────────────── NotAppl
│       │     │     └ ≥77.5:──────────────────────── 24HrNight
│       │     └ ≥3.:──────────────────────────────── NotAppl
│       └ ≥4.:GGLAT??
│             ├ <77.5:MO??
│             │       ├ <5.:──────────────────────── NotAppl
│             │       └ ≥5.:GGLAT??
│             │             ├ <67.5:──────────────── NotAppl
│             │             └ ≥67.5:MO??
│             │                     ├ <8.:────────── 24HrDay
│             │                     └ ≥8.:GGLAT??
│             │                           ├ <72.5:── NotAppl
│             │                           └ ≥72.5:── 24HrDay
│             └ ≥77.5:────────────────────────────── 24HrDay
└ ≥9.:MO??
        ├ <11.:GGLAT??
        │     ├ <82.5:────────────────────────────── NotAppl
        │     └ ≥82.5:MO??
        │             ├ <10.:─────────────────────── NotAppl
        │             └ ≥10.:─────────────────────── 24HrNight
        └ ≥11.:GGLAT??
              ├ <72.5:GGLAT??
              │       ├ <67.5:────────────────────── NotAppl
              │       └ ≥67.5:MO??
              │               ├ <12.:─────────────── NotAppl
              │               └ ≥12.:─────────────── 24HrNight
              └ ≥72.5:────────────────────────────── 24HrNight
```

#FCFlr

Rule for knowledge base FCFlr 10:55 am 07/15/1992

```
    MEMO
1:  #DATAPREP??
2:  └:#SIDINIT??
3:     └:#FLRSZCUR??
4:        └:------------------------------------------- no_data
```

#DataPrep

Rule for knowledge base DataPrep 10:56 am 07/15/1992

```
1: #SSN??
2: └:————————————————————————————— no_data
```

#SSN

Rule for knowledge base SSN 8:40 am 07/07/1992

```
1: SSNTABLE??
2: └:──────────────────────────────────────────── no_data
```

#SIDInit

Rule for knowledge base SIDInit 10:35 am 07/15/1992

```
MEMO
FLRSZINIT??
├No_Flare:──────────────────────────────────────── #EXIT:1
├Small:TODPOLAR??
│      ├24HrDay:────────────────────────────────── Negligible
│      ├24HrNight:──────────────────────────────── Negligible
│      ├NotAppl:TODFLR??
│      │        ├Sunrise:───────────────────────── Negligible
│      │        ├Morning:───────────────────────── Negligible
│      │        ├Noon:──────────────────────────── Slight
│      │        ├Afternoon:─────────────────────── Negligible
│      │        ├Sunset:────────────────────────── Negligible
│      │        ├PreMNight:─────────────────────── Negligible
│      │        ├MidNight:──────────────────────── Negligible
│      │        └PostMNight:────────────────────── Negligible
│      └InErrGgLat:─────────────────────────────── #EXIT:1
├Med:TODPOLAR??
│    ├24HrDay:──────────────────────────────────── Slight
│    ├24HrNight:────────────────────────────────── Negligible
│    ├NotAppl:TODFLR??
│    │        ├Sunrise:─────────────────────────── Negligible
│    │        ├Morning:─────────────────────────── Slight
│    │        ├Noon:────────────────────────────── Moderate
│    │        ├Afternoon:───────────────────────── Slight
│    │        ├Sunset:──────────────────────────── Negligible
│    │        ├PreMNight:───────────────────────── Negligible
│    │        ├MidNight:────────────────────────── Negligible
│    │        └PostMNight:──────────────────────── Negligible
│    └InErrGgLat:───────────────────────────────── #EXIT:1
├Large:TODPOLAR??
│      ├24HrDay:────────────────────────────────── Moderate
│      ├24HrNight:──────────────────────────────── Negligible
│      ├NotAppl:TODFLR??
│      │        ├Sunrise:───────────────────────── Slight
│      │        ├Morning:───────────────────────── Moderate
│      │        ├Noon:──────────────────────────── Substantial
│      │        ├Afternoon:─────────────────────── Moderate
│      │        ├Sunset:────────────────────────── Slight
│      │        ├PreMNight:─────────────────────── Negligible
│      │        ├MidNight:──────────────────────── Negligible
│      │        └PostMNight:────────────────────── Negligible
│      └InErrGgLat:─────────────────────────────── #EXIT:1
```

```
42: └Very_Large:TODPOLAR??
43:            ├24HrDay:──────────────────────────────── Substantial
44:            ├24HrNight:────────────────────────────── Negligible
45:            ├NotAppl:TODFLR??
46:            │        ├Sunrise:─────────────────────── Moderate
47:            │        ├Morning:─────────────────────── Substantial
48:            │        ├Noon:────────────────────────── Severe
49:            │        ├Afternoon:───────────────────── Substantial
50:            │        ├Sunset:──────────────────────── Substantial
51:            │        ├PreMNight:───────────────────── Negligible
52:            │        ├MidNight:────────────────────── Negligible
53:            │        └PostMNight:──────────────────── Negligible
54:            └InErrGgLat:───────────────────────────── #EXIT:1
```

#FlrSzCur

```
Rule for knowledge base FlrSzCur                10:56 am  07/15/1992

MEMO
FLRSZINIT??
├No_Flare:──────────────────────────────────────────────── Nil
├Small:─────────────────────────────────────────────────── Nil
├Med:TPFM??
│        ├ <15.:TPFM??
│        │         ├ <9.:───────────────────────────────── Med
│        │         └ ≥9.:───────────────────────────────── Small
│        └ ≥15.:────────────────────────────────────────── Nil
├Large:TPFM??
│          ├ <45.:TPFM??
│          │          ├ <30.:───────────────────────────── Med
│          │          └ ≥30.:───────────────────────────── Small
│          └ ≥45.:──────────────────────────────────────── Nil
└Very_Large:TPFM??
             ├ <150.:TPFM??
             │          ├ <90.:TPFM??
             │          │         ├ <45.:───────────────── Very_Large
             │          │         └ ≥45.:───────────────── Large
             │          └ ≥90.:─────────────────────────── Med
             └ ≥150.:TPFM??
                        ├ <192.:────────────────────────── Small
                        └ ≥192.:────────────────────────── Nil
```

#FCEvent

Rule for knowledge base FCEvent 10:56 am 07/15/1992

```
    MEMO
1:  #EVSID??
2:  └:#EVPCA??
3:    └:#EVIS??
4:      └:#EVAUR??
5:        └:#EVAZA??
6:          └:──────────────────────────────────────── no_data
```

#EvSID

Rule for knowledge base EvSID 10:57 am 07/15/1992

```
    MEMO
 1: TPFM??
 2: ├ <6.00005:──────────────────────────────────────── NotLikely
 3: └ ≥6.00005:TPFM??
 4:            ├ <360.:#HILATSID??
 5:            │         ├Likely:──────────────────────── Likely
 6:            │         ├NotLikely:───────────────────── NotLikely
 7:            │         └NotAppl:GMLAT??
 8:            │                  ├ <27.5:────────────── NotLikely
 9:            │                  └ ≥27.5:GMLAT??
10:            │                          ├ <67.5:TODCUR??
11:            │                          │       ├Sunrise:- Likely
12:            │                          │       ├Morning:- Likely
13:            │                          │       ├Noon:- Likely
14:            │                          │       ├Afternoon:- Likely
15:            │                          │       ├Sunset:- NotLikely
16:            │                          │       ├PreMNight:- NotLikely
17:            │                          │       ├MidNight:- NotLikely
18:            │                          │       └PostMNight:- NotLikely
19:            │                          └ ≥67.5:──── NotLikely
20:            └ ≥360.:───────────────────────────────── NotLikely
```

#HiLatSID

Rule for knowledge base HiLatSID 10:57 am 07/15/1992

```
MEMO
TODPOLAR??
├24HrDay:TPFM??
│         ├ ≤6.:──────────────────────────────── NotLikely
│         └ >6.:TPFM??
│                    ├ ≤360.:────────────────────── Likely
│                    └ >360.:────────────────────── NotLikely
├24HrNight:─────────────────────────────────────── NotLikely
└NotAppl:───────────────────────────────────────── NotAppl
```

#EvPCA

Rule for knowledge base EvPCA   10:57 am 07/15/1992

```
MEMO
#PCAPROT??
├Yes:TPFM??
│       ├ <30.:──────────────────────────────────────────── NotLikely
│       └ ≥30.:GMLAT??
│                    ├ <62.5:────────────────────────────── NotLikely
│                    └ ≥62.5:TPFM??
│                            ├ <360.:────────────────────── Likely
│                            └ ≥360.:TPFM??
│                                        ├ <3600.:──── InProgress
│                                        └ ≥3600.:──── NotLikely
└No:─────────────────────────────────────────────────────── NotLikely
```

#PCAProt

Rule for knowledge base PCAProt 10:57 am 07/15/1992

```
    MEMO
 1: PROTONS??
 2: ├Yes_or_NotK:────────────────────────────────── Yes
 3: └No:─────────────────────────────────────────── No
```

#EvIS

Rule for knowledge base EvIS 10:57 am 07/15/1992

```
MEMO
TODCUR??
├Sunrise:GMLAT??
│           ├ <27.5:──────────────────────────────────── NotLikely
│           └ ≥27.5:GMLAT??
│                   ├ <62.5:TPFM??
│                   │       ├ <1440.05:─────── ──────── NotLikely
│                   │       └ ≥1440.05:TPFM??
│                   │                  ├ <5760.05:─── Likely
│                   │                  └ ≥5760.05:─── NotLikely
│                   └ ≥62.5:──────────────────────────── NotLikely
├Morning:GMLAT??
│           ├ <27.5:──────────────────────────────────── NotLikely
│           └ ≥27.5:GMLAT??
│                   ├ <62.5:TPFM??
│                   │       ├ <1440.05:──────────────── NotLikely
│                   │       └ ≥1440.05:TPFM??
│                   │                  ├ <5760.05:─── Likely
│                   │                  └ ≥5760.05:─── NotLikely
│                   └ ≥62.5:──────────────────────────── NotLikely
├Noon:GMLAT??
│        ├ <27.5:─────────────────────────────────────── NotLikely
│        └ ≥27.5:GMLAT??
│                ├ <62.5:TPFM??
│                │       ├ <1440.05:─────────────────── NotLikely
│                │       └ ≥1440.05:TPFM??
│                │                  ├ <5760.05:──────── Likely
│                │                  └ ≥5760.05:──────── NotLikely
│                └ ≥62.5:─────────────────────────────── NotLikely
├Afternoon:GMLAT??
│             ├ <27.5:────────────────────────────────── NotLikely
│             └ ≥27.5:GMLAT??
│                     ├ <62.5:TPFM??
│                     │       ├ <1440.05:────────────── NotLikely
│                     │       └ ≥1440.05:TPFM??
│                     │                  ├ <5760.05:─── Likely
│                     │                  └ ≥5760.05:─── NotLikely
│                     └ ≥62.5:────────────────────────── NotLikely
├Sunset:──────────────────────────────────────────────── NotLikely
├PreMNight:───────────────────────────────────────────── NotLikely
├MidNight:────────────────────────────────────────────── NotLikely
└PostMNight:──────────────────────────────────────────── NotLikely
```

#EvAur

Rule for knowledge base EvAur   10:58 am 07/15/1992

```
   MEMO
1: KP??
2: ├ <2.00005:───────────────────────────────────── NotLikely
3: └ ≥2.00005:GMLAT??
4:            ├ <47.5:───────────────────────────── NotLikely
5:            └ ≥47.5:GMLAT??
6:                    ├ <72.5:───────────────────── Likely
7:                    └ ≥72.5:───────────────────── NotLikely
```

#EvAZA

Rule for knowledge base EvAZA 10:58 am 07/15/1992

```
MEMO
GMLAT??
├ <47.5:─────────────────────────────────────────── NotLikely
└ ≥47.5:TPFM??
        ├ <1440.01:─────────────────────────────── NotLikely
        └ ≥1440.01:TODCUR??
                   ├Sunrise:────────────────────── NotLikely
                   ├Morning:GMLAT??
                   │        ├ <72.5:TPFM??
                   │        │            ├ <5760.01:─── Likely
                   │        │            └ ≥5760.01:─── NotLikely
                   │        └ ≥72.5:────────────── NotLikely
                   ├Noon:GMLAT??
                   │     ├ <72.5:TPFM??
                   │     │            ├ <5760.01:─── Likely
                   │     │            └ ≥5760.01:─── NotLikely
                   │     └ ≥72.5:───────────────── NotLikely
                   ├Afternoon:──────────────────── NotLikely
                   ├Sunset:─────────────────────── NotLikely
                   ├PreMNight:──────────────────── NotLikely
                   ├MidNight:GMLAT??
                   │         ├ <72.5:TPFM??
                   │         │            ├ <5760.01:─── Likely
                   │         │            └ ≥5760.01:─── NotLikely
                   │         └ ≥72.5:───────────── NotLikely
                   └PostMNight:─────────────────── NotLikely
```

#2FCSID

Rule for knowledge base 2FCSID 9:03 am 07/07/1992

```
   MEMO
1: EVSID??
2: ├Likely:──────────────────────────────────────── #FCSID
3: └NotLikely:───────────────────────────────────── ˜Return
```

#FCSID

Rule for knowledge base FCSID 9:08 am 07/07/1992

```
MEMO
HILATSID??
├Likely:──────────────────────────────────────── Normal
├NotLikely:───────────────────────────────────── Normal
└NotAppl:#PATH??
         ├Short:FLRSZCUR??
         │      ├Nil:──────────────────────────── Normal
         │      ├Small:────────────────────────── 09
         │      ├Med:──────────────────────────── 11
         │      ├Large:────────────────────────── 13
         │      └Very_Large:───────────────────── BlkOut
         ├Med:FLRSZCUR??
         │    ├Nil:────────────────────────────── Normal
         │    ├Small:──────────────────────────── 13
         │    ├Med:────────────────────────────── 16
         │    ├Large:──────────────────────────── 19
         │    └Very_Large:─────────────────────── BlkOut
         ├Long:FLRSZCUR??
         │     ├Nil:───────────────────────────── Normal
         │     ├Small:─────────────────────────── 17
         │     ├Med:───────────────────────────── 22
         │     ├Large:─────────────────────────── 27
         │     └Very_Large:────────────────────── BlkOut
         └InputErrDis:─────────────────────────── Normal
```

#Path

Rule for knowledge base Path   10:58 am 07/15/1992

```
DIS??
├ <1000.:DIS??
│         ├ <0.:──────────────────────────────── InputErrDis
│         └ ≥0.:──────────────────────────────── Short
└ ≥1000.:DIS??
          ├ <2500.:───────────────────────────── Med
          └ ≥2500.:DIS??
                    ├ <20016.:────────────────── Long
                    └ ≥20016.:────────────────── InputErrDis
```

#2FCPCA

Rule for knowledge base 2FCPCA 9:08 am 07/07/1992

```
    MEMO
1:  EVPCA??
2:  ├InProgress:──────────────────────── #FCPCANow
3:  ├Likely:──────────────────────────── #FCPCA
4:  └NotLikely:───────────────────────── ~Return
```

#FCPCA

Rule for knowledge base FCPCA 9:13 am 07/07/1992

```
    MEMO
 1: #PCAPROB??
 2: └:#PCAONSET??
 3:    └:#PCALOSS??
 4:       └:#PCADUR??
 5:          └:────────────────────────────── no_data
```

#PCAProb

Rule for knowledge base PCAProb 10:58 am 07/15/1992

```
 1: SSN??
 2: ├ <85.:SSN??
 3: │      ├ <17.5:────────────────────────────────── 8pct
 4: │      └ ≥17.5:SSN??
 5: │              ├ <57.5:SSN??
 6: │              │       ├ <40.:─────────────────── 16pct
 7: │              │       └ ≥40.:─────────────────── 25pct
 8: │              └ ≥57.5:────────────────────────── 41pct
 9: └ ≥85.:SSN??
10:        ├ <145.:SSN??
11:        │       ├ <135.:────────────────────────── 50pct
12:        │       └ ≥135.:────────────────────────── 58pct
13:        └ ≥145.:SSN??
14:                ├ <160.:────────────────────────── 75pct
15:                └ ≥160.:────────────────────────── 100pct
```

#PCAOnset

Rule for knowledge base PCAOnset 10:58 am 07/15/1992

```
 1: FLRLOC??
 2: ├90E:──────────────────────────────── 5.7
 3: ├75E:──────────────────────────────── 5.2
 4: ├60E:──────────────────────────────── 4.8
 5: ├45E:──────────────────────────────── 4.3
 6: ├30E:──────────────────────────────── 3.9
 7: ├15E:──────────────────────────────── 3.5
 8: ├0:────────────────────────────────── 3.0
 9: ├15W:──────────────────────────────── 2.5
10: ├30W:──────────────────────────────── 2.1
11: ├45W:──────────────────────────────── 1.6
12: ├60W:──────────────────────────────── 1.2
13: ├75W:──────────────────────────────── 0.7
14: ├90W:──────────────────────────────── 0.3
15: └NotKnown:─────────────────────────── 3.0
```

#PCALoss

Rule for knowledge base PCALoss 10:59 am 07/15/1992

```
1: TODPCA??
2: ├Day:──────────────────────────────────────────── DayLoss
3: └Night:────────────────────────────────────────── NightLoss
```

#PCADur

Rule for knowledge base PCADur   10:59 am   07/15/1992

```
1: GMLON??
2: ├ <-50.:GMLON??
3: │            ├ <-130.:──────────────────────── #PCADur1
4: │            └ ≥-130.:──────────────────────── #PCADur2
5: └ ≥-50.:GMLON??
6:              ├ <9.99995:─────────────────────── #PCADur3
7:              └ ≥9.99995:GMLON??
8:                         ├ <170.:─────────────── #PCADur4
9:                         └ ≥170.:─────────────── #PCADur1
```

#PCADurl

Rule for knowledge base PCADurl 10:59 am 07/15/1992

```
1: GMLAT??
2: ├ <72.5:GMLAT??
3: │         ├ <62.5:─────────────────────────────── Nil
4: │         └ ≥62.5:GMLAT??
5: │                   ├ <67.5:──────────────────────── 30Hrs
6: │                   └ ≥67.5:──────────────────────── 52Hrs
7: └ ≥72.5:GMLAT??
8:           ├ <82.5:─────────────────────────────── 60Hrs
9:           └ ≥82.5:─────────────────────────────── GT_60Hrs
```

#PCADur2

Rule for knowledge base PCADur2 10:59 am 07/15/1992

```
 1: GMLAT??
 2: ├ <57.5:GMLAT??
 3: │        ├ <37.5:─────────────────────────────── Nil
 4: │        └ ≥37.5:GMLAT??
 5: │                 ├ <47.5:GMLAT??
 6: │                 │        ├ <42.5:──────────── 05Hrs
 7: │                 │        └ ≥42.5:──────────── 10Hrs
 8: │                 └ ≥47.5:GMLAT??
 9: │                          ├ <52.5:──────────── 18Hrs
10: │                          └ ≥52.5:──────────── 30Hrs
11: └ ≥57.5:GMLAT??
12:          ├ <72.5:GMLAT??
13:          │        ├ <62.5:───────────────────── 42Hrs
14:          │        └ ≥62.5:GMLAT??
15:          │                 ├ <67.5:──────────── 48Hrs
16:          │                 └ ≥67.5:──────────── 52Hrs
17:          └ ≥72.5:GMLAT??
18:                   ├ <82.5:GMLAT??
19:                   │        ├ <77.5:──────────── 55Hrs
20:                   │        └ ≥77.5:──────────── 60Hrs
21:                   └ ≥82.5:───────────────────── GT_60Hrs
```

#PCADur3

Rule for knowledge base PCADur3 10:59 am 07/15/1992

```
GMLAT??
├ <57.5:──────────────────────────────────────── Nil
└ ≥57.5:GMLAT??
          ├ <72.5:GMLAT??
          │         ├ <62.5:──────────────────────────── 06Hrs
          │         └ ≥62.5:GMLAT??
          │                   ├ <67.5:────────────────── 30Hrs
          │                   └ ≥67.5:────────────────── 45Hrs
          └ ≥72.5:GMLAT??
                    ├ <82.5:GMLAT??
                    │         ├ <77.5:────────────────── 54Hrs
                    │         └ ≥77.5:────────────────── 60Hrs
                    └ ≥82.5:──────────────────────────── GT_60Hrs
```

#PCADur4

Rule for knowledge base PCADur4 10:59 am 07/15/1992

1: ———————————————————————————— NotKnown

#FCPCANow

Rule for knowledge base FCPCANow 11:00 am 07/15/1992

```
   MEMO
1: #PCAABS??
2: └:#AFRANGE??
3:    └:─────────────────────────────────────────────── no_data
```

#PCAAbs

Rule for knowledge base PCAAbs 11:00 am 07/15/1992

```
TODPCA??
├Day:TENMEVFLUX??
│        ├ <85.:TENMEVFLUX??
│        │         ├ <8.5:TENMEVFLUX??
│        │         │         ├ <4.5:TENMEVFLUX??
│        │         │         │         ├ <2.5:TENMEVFLUX??
│        │         │         │         │         ├ <1.5:────────── 0.40
│        │         │         │         │         └ ≥1.5:────────── 0.60
│        │         │         │         └ ≥2.5:TENMEVFLUX??
│        │         │         │                   ├ <3.5:────────── 0.70
│        │         │         │                   └ ≥3.5:────────── 0.80
│        │         │         └ ≥4.5:TENMEVFLUX??
│        │         │                   ├ <6.5:TENMEVFLUX??
│        │         │                   │         ├ <5.5:────────── 0.90
│        │         │                   │         └ ≥5.5:────────── 1.0
│        │         │                   └ ≥6.5:TENMEVFLUX??
│        │         │                             ├ <7.5:────────── 1.1
│        │         │                             └ ≥7.5:────────── 1.2
│        │         └ ≥8.5:TENMEVFLUX??
│        │                   ├ <35.:TENMEVFLUX??
│        │                   │         ├ <15.:TENMEVFLUX??
│        │                   │         │         ├ <9.5:────────── 1.3
│        │                   │         │         └ ≥9.5:────────── 1.4
│        │                   │         └ ≥15.:TENMEVFLUX??
│        │                   │                   ├ <25.:────────── 1.8
│        │                   │                   └ ≥25.:────────── 2.2
│        │                   └ ≥35.:TENMEVFLUX??
│        │                             ├ <55.:TENMEVFLUX??
│        │                             │         ├ <45.:────────── 2.5
│        │                             │         └ ≥45.:────────── 2.8
│        │                             └ ≥55.:TENMEVFLUX??
│        │                                       ├ <65.:────────── 3.0
│        │                                       └ ≥65.:TENMEVFLUX??
│        │                                                 ├ <75.:──── 3.3
│        │                                                 └ ≥75.:──── 3.5
│        │
```

```
└ ≥85.:TENMEVFLUX??
      ├ <475.:TENMEVFLUX??
      │      ├ <225.:TENMEVFLUX??
      │      │      ├ <125.:TENMEVFLUX??
      │      │      │      ├ <95.:────── 3.8
      │      │      │      └ ≥95.:────── 4.0
      │      │      └ ≥125.:TENMEVFLUX??
      │      │             ├ <175.:───── 5.0
      │      │             └ ≥175.:───── 5.5
      │      └ ≥225.:TENMEVFLUX??
      │             ├ <325.:TENMEVFLUX??
      │             │      ├ <275.:───── 6.2
      │             │      └ ≥275.:───── 7.0
      │             └ ≥325.:TENMEVFLUX??
      │                    ├ <375.:───── 7.5
      │                    └ ≥375.:TENMEVFLUX??
      │                           ├ <425.:──── 8.0
      │                           └ ≥425.:──── 8.5
      └ ≥475.:TENMEVFLUX??
             ├ <750.:TENMEVFLUX??
             │      ├ <575.:TENMEVFLUX??
             │      │      ├ <525.:───── 9.0
             │      │      └ ≥525.:───── 9.5
             │      └ ≥575.:TENMEVFLUX??
             │             ├ <650.:───── 10
             │             └ ≥650.:───── 11
             └ ≥750.:TENMEVFLUX??
                    ├ <950.:TENMEVFLUX??
                    │      ├ <850.:───── 12
                    │      └ ≥850.:───── 13
                    └ ≥950.:TENMEVFLUX??
                           ├ <1100.:──── 14
                           └ ≥1100.:TENMEVFLUX??
                                  ├ <1350.:──── 16
                                  └ ≥1350.:──── 18
```

```
└Night:TENMEVFLUX??
          ├ <85.:TENMEVFLUX??
          │         ├ <8.5:TENMEVFLUX??
          │         │         ├ <4.5:TENMEVFLUX??
          │         │         │         ├ <2.5:TENMEVFLUX??
          │         │         │         │         ├ <1.5:─────────── 0.08
          │         │         │         │         └ ≥1.5:─────────── 0.12
          │         │         │         └ ≥2.5:TENMEVFLUX??
          │         │         │                   ├ <3.5:─────────── 0.14
          │         │         │                   └ ≥3.5:─────────── 0.16
          │         │         └ ≥4.5:TENMEVFLUX??
          │         │                   ├ <5.5:───────────────────── 0.18
          │         │                   └ ≥5.5:TENMEVFLUX??
          │         │                             ├ <7.5:─────────── 0.22
          │         │                             └ ≥7.5:─────────── 0.24
          │         └ ≥8.5:TENMEVFLUX??
          │                   ├ <35.:TENMEVFLUX??
          │                   │         ├ <15.:TENMEVFLUX??
          │                   │         │         ├ <9.5:─────────── 0.26
          │                   │         │         └ ≥9.5:─────────── 0.28
          │                   │         └ ≥15.:TENMEVFLUX??
          │                   │                   ├ <25.:─────────── 0.36
          │                   │                   └ ≥25.:─────────── 0.44
          │                   └ ≥35.:TENMEVFLUX??
          │                             ├ <55.:TENMEVFLUX??
          │                             │         ├ <45.:─────────── 0.50
          │                             │         └ ≥45.:─────────── 0.55
          │                             └ ≥55.:TENMEVFLUX??
          │                                       ├ <65.:─────────── 0.60
          │                                       └ ≥65.:TENMEVFLUX??
          │                                                 ├ <75.:──── 0.66
          │                                                 └ ≥75.:──── 0.70
          └ ≥85.:TENMEVFLUX??
                    ├ <475.:TENMEVFLUX??
                    │         ├ <225.:TENMEVFLUX??
                    │         │         ├ <125.:TENMEVFLUX??
                    │         │         │         ├ <95.:─────── 0.75
                    │         │         │         └ ≥95.:─────── 0.80
                    │         │         └ ≥125.:TENMEVFLUX??
                    │         │                   ├ <175.:───── 1.0
                    │         │                   └ ≥175.:───── 1.1
                    │         └ ≥225.:TENMEVFLUX??
                    │                   ├ <325.:TENMEVFLUX??
                    │                   │         ├ <275.:───── 1.2
                    │                   │         └ ≥275.:───── 1.4
                    │                   └ ≥325.:TENMEVFLUX??
                    │                             ├ <375.:───── 1.5
                    │                             └ ≥375.:TENMEVFLUX??
                    │                                       ├ <425.:───── 1.6
                    │                                       └ ≥425.:───── 1.7
                    │
```

```
121:                └ ≥475.:TENMEVFLUX??
122:                        ├ <750.:TENMEVFLUX??
123:                        │       ├ <575.:TENMEVFLUX??
124:                        │       │       ├ <525.:──── 1.8
125:                        │       │       └ ≥525.:──── 1.9
126:                        │       └ ≥575.:TENMEVFLUX??
127:                        │               ├ <650.:──── 2.0
128:                        │               └ ≥650.:──── 2.2
129:                        └ ≥750.:TENMEVFLUX??
130:                                ├ <950.:TENMEVFLUX??
131:                                │       ├ <850.:──── 2.4
132:                                │       └ ≥850.:──── 2.6
133:                                └ ≥950.:TENMEVFLUX??
134:                                        ├ <1100.:──── 2.8
135:                                        └ ≥1100.:TENMEVFLUX??
136:                                                 ├ <1350.:──── 3.2
137:                                                 └ ≥1350.:──── 3.6
```

#AfRange

Rule for knowledge base AfRange   11:00 am 07/15/1992

```
PCAAF??
├ <30.:PCAAF??
│        ├ <0.:──────────────────────────── InErrPCAAf
│        └ ≥0.:PCAAF??
│               ├ <10.:──────────────────── LT10dB
│               └ ≥10.:──────────────────── 10to30dB
└ ≥30.:PCAAF??
         ├ <50.:─────────────────────────── 30to50dB
         └ ≥50.:PCAAF??
                 ├ <100.:────────────────── 50to100dB
                 └ ≥100.:────────────────── GT100dB
```

#2FCIS

Rule for knowledge base 2FCIS 9:17 am 07/07/1992

```
    MEMO
 1: EVIS??
 2: ├Likely:──────────────────────────────────────────── #FCIS
 3: └NotLikely:───────────────────────────────────────── ˉReturn
```

#FCIS

Rule for knowledge base FCIS 9:20 am 07/07/1992

```
   MEMO
1: #ISPROB??
2: └:#ISLOSS??
3:   └:#ISDUR??
4:     └:#TECHANGE??
5:       └:──────────────────────────────── no_data
```

#ISProb

Rule for knowledge base ISProb 11:01 am 07/15/1992

```
UTQ??
├00:MO??
│    ├ <10.5:MO??
│    │       ├ <7.5:MO??
│    │       │      ├ <5.5:MO??
│    │       │      │      ├ <1.5:───────────────── Low
│    │       │      │      └ ≥1.5:MO??
│    │       │      │             ├ <2.5:────────── Med
│    │       │      │             └ ≥2.5:MO??
│    │       │      │                    ├ <4.5:─── High
│    │       │      │                    └ ≥4.5:─── Med
│    │       │      └ ≥5.5:──────────────────────── Low
│    │       └ ≥7.5:MO??
│    │              ├ <8.5:──────────────────────── Med
│    │              └ ≥8.5:MO??
│    │                     ├ <9.5:───────────────── High
│    │                     └ ≥9.5:───────────────── Med
│    └ ≥10.5:────────────────────────────────────── Low
├06:MO??
│    ├ <9.5:MO??
│    │      ├ <2.5:──────────────────────────────── Low
│    │      └ ≥2.5:MO??
│    │             ├ <7.5:MO??
│    │             │      ├ <5.5:MO??
│    │             │      │      ├ <3.5:─────────── Med
│    │             │      │      └ ≥3.5:─────────── High
│    │             │      └ ≥5.5:────────────────── Med
│    │             └ ≥7.5:───────────────────────── High
│    └ ≥9.5:─────────────────────────────────────── Low
├12:MO??
│    ├ <8.5:MO??
│    │      ├ <4.5:MO??
│    │      │      ├ <1.5:───────────────────────── Low
│    │      │      └ ≥1.5:MO??
│    │      │             ├ <2.5:────────────────── Med
│    │      │             └ ≥2.5:MO??
│    │      │                    ├ <3.5:─────────── High
│    │      │                    └ ≥3.5:─────────── Med
│    │      └ ≥4.5:MO??
│    │             ├ <7.5:───────────────────────── Low
│    │             └ ≥7.5:───────────────────────── Med
│    └ ≥8.5:MO??
│           ├ <10.5:─────────────────────────────── High
│           └ ≥10.5:MO??
│                  ├ <11.5:──────────────────────── Med
│                  └ ≥11.5:──────────────────────── Low
```

```
└18:MO??
    ├ <3.5:MO??
    │       ├ <1.5:────────────────────────────────── Med
    │       └ ≥1.5:────────────────────────────────── High
    └ ≥3.5:MO??
            ├ <8.5:────────────────────────────────── Low
            └ ≥8.5:MO??
                    ├ <9.5:────────────────────────── Med
                    └ ≥9.5:MO??
                            ├ <11.5:───────────────── High
                            └ ≥11.5:───────────────── Low
```

#ISLoss

Rule for knowledge base ISLoss 11:01 am 07/15/1992

```
MEMO
ISPROB??
├Low:GMLAT??
│  ├ <62.5:GMLAT??
│  │  ├ <37.5:──────────────────────────────── NoneLatOOB
│  │  └ ≥37.5:──────────────────────────────── LT10pct
│  └ ≥62.5:─────────────────────────────────── 0pct
├Med:GMLAT??
│  ├ <62.5:GMLAT??
│  │  ├ <37.5:──────────────────────────────── NoneLatOOB
│  │  └ ≥37.5:──────────────────────────────── LT10pct
│  └ ≥62.5:─────────────────────────────────── 0pct
└High:TODIS??
   ├Morning:GMLAT??
   │  ├ <47.5:KP??
   │  │  ├ <5.5:GMLAT??
   │  │  │  ├ <37.5:────────────────────────── NoneLatOOB
   │  │  │  └ ≥37.5:GMLAT??
   │  │  │     ├ <42.5:KP??
   │  │  │     │  ├ <3.5:KP??
   │  │  │     │  │  ├ <2.5:────────────────── 0pct
   │  │  │     │  │  └ ≥2.5:────────────────── 05pct
   │  │  │     │  └ ≥3.5:KP??
   │  │  │     │     ├ <4.5:────────────────── 14pct
   │  │  │     │     └ ≥4.5:────────────────── 23pct
   │  │  │     └ ≥42.5:KP??
   │  │  │        ├ <3.5:KP??
   │  │  │        │  ├ <2.5:────────────────── 0pct
   │  │  │        │  └ ≥2.5:────────────────── 05pct
   │  │  │        └ ≥3.5:KP??
   │  │  │           ├ <4.5:────────────────── 14pct
   │  │  │           └ ≥4.5:────────────────── 23pct
   │  │  └ ≥5.5:GMLAT??
   │  │     ├ <37.5:────────────────────────── NoneLatOOB
   │  │     └ ≥37.5:GMLAT??
   │  │        ├ <42.5:KP??
   │  │        │  ├ <7.5:KP??
   │  │        │  │  ├ <6.5:────────────────── 33pct
   │  │        │  │  └ ≥6.5:────────────────── 41pct
   │  │        │  └ ≥7.5:KP??
   │  │        │     ├ <8.5:────────────────── 50pct
   │  │        │     └ ≥8.5:────────────────── 60pct
   │  │        └ ≥42.5:KP??
   │  │           ├ <7.5:KP??
   │  │           │  ├ <6.5:────────────────── 33pct
   │  │           │  └ ≥6.5:────────────────── 41pct
   │  │           └ ≥7.5:KP??
   │  │              ├ <8.5:────────────────── 50pct
   │  │              └ ≥8.5:────────────────── 60pct
```

```
49: │   └ ≥47.5:KP??
50: │       ├ <6.5:GMLAT??
51: │       │   ├ <57.5:──────────────────────────────── 0pct
52: │       │   └ ≥57.5:GMLAT??
53: │       │       ├ <62.5:KP??
54: │       │       │   ├ <4.5:────────────────────────── 0pct
55: │       │       │   └ ≥4.5:KP??
56: │       │       │       ├ <5.5:────────────────────── 03pct
57: │       │       │       └ ≥5.5:────────────────────── 13pct
58: │       │       └ ≥62.5:───────────────────────────── 0pct
59: │       └ ≥6.5:GMLAT??
60: │           ├ <57.5:GMLAT??
61: │           │   ├ <52.5:KP??
62: │           │   │   ├ <7.5:────────────────────────── 06pct
63: │           │   │   └ ≥7.5:KP??
64: │           │   │       ├ <8.5:────────────────────── 15pct
65: │           │   │       └ ≥8.5:────────────────────── 25pct
66: │           │   └ ≥52.5:KP??
67: │           │       ├ <7.5:────────────────────────── 06pct
68: │           │       └ ≥7.5:KP??
69: │           │           ├ <8.5:────────────────────── 15pct
70: │           │           └ ≥8.5:────────────────────── 25pct
71: │           └ ≥57.5:GMLAT??
72: │               ├ <62.5:KP??
73: │               │   ├ <7.5:────────────────────────── 21pct
74: │               │   └ ≥7.5:KP??
75: │               │       ├ <8.5:────────────────────── 30pct
76: │               │       └ ≥8.5:────────────────────── 40pct
77: │               └ ≥62.5:───────────────────────────── 0pct
78: ├Afternoon:GMLAT??
79: │   ├ <57.5:KP??
80: │   │   ├ <6.5:GMLAT??
81: │   │   │   ├ <37.5:──────────────────────────────── NoneLatOOB
82: │   │   │   └ ≥37.5:──────────────────────────────── 0pct
83: │   │   └ ≥6.5:GMLAT??
84: │   │       ├ <47.5:GMLAT??
85: │   │       │   ├ <37.5:──────────────────────────── NoneLatOOB
86: │   │       │   └ ≥37.5:──────────────────────────── 0pct
87: │   │       └ ≥47.5:GMLAT??
88: │   │           ├ <52.5:KP??
89: │   │           │   ├ <7.5:────────────────────────── 06pct
90: │   │           │   └ ≥7.5:KP??
91: │   │           │       ├ <8.5:────────────────────── 15pct
92: │   │           │       └ ≥8.5:────────────────────── 25pct
93: │   │           └ ≥52.5:KP??
94: │   │               ├ <7.5:────────────────────────── 06pct
95: │   │               └ ≥7.5:KP??
96: │   │                   ├ <8.5:────────────────────── 15pct
97: │   │                   └ ≥8.5:────────────────────── 25pct
```

```
│ └ ≥57.5:KP??
│   ├ <7.5:GMLAT??
│   │ ├ <62.5:KP??
│   │ │ ├ <4.5:KP??
│   │ │ │ ├ <2.5:──────────────────────────────── 0pct
│   │ │ │ └ ≥2.5:KP??
│   │ │ │   ├ <3.5:────────────────────────────── 10pct
│   │ │ │   └ ≥3.5:────────────────────────────── 19pct
│   │ │ └ ≥4.5:KP??
│   │ │   ├ <5.5:──────────────────────────────── 28pct
│   │ │   └ ≥5.5:KP??
│   │ │     ├ <6.5:────────────────────────────── 39pct
│   │ │     └ ≥6.5:────────────────────────────── 46pct
│   │ └ ≥62.5:──────────────────────────────────── 0pct
│   └ ≥7.5:GMLAT??
│     ├ <62.5:KP??
│     │ ├ <8.5:──────────────────────────────────── 55pct
│     │ └ ≥8.5:──────────────────────────────────── 65pct
│     └ ≥62.5:GMLAT??
│       ├ <87.5:GMLAT??
│       │ ├ <75.:KP??
│       │ │ ├ <8.5:────────────────────────────── 05pct
│       │ │ └ ≥8.5:────────────────────────────── 15pct
│       │ └ ≥75.:KP??
│       │   ├ <8.5:────────────────────────────── 05pct
│       │   └ ≥8.5:────────────────────────────── 15pct
│       └ ≥87.5:──────────────────────────────────── 0pct
```

```
125:   └Night:GMLAT??
126:     ├ <57.5:KP??
127:     │ ├ <5.5:GMLAT??
128:     │ │ ├ <37.5:──────────────────────────── NoneLatOOB
129:     │ │ └ ≥37.5:GMLAT??
130:     │ │   ├ <42.5:─────────────────────────── 0pct
131:     │ │   └ ≥42.5:GMLAT??
132:     │ │     ├ <47.5:KP??
133:     │ │     │ ├ <3.5:KP??
134:     │ │     │ │ ├ <2.5:────────────────────── 0pct
135:     │ │     │ │ └ ≥2.5:────────────────────── 05pct
136:     │ │     │ └ ≥3.5:KP??
137:     │ │     │   ├ <4.5:────────────────────── 14pct
138:     │ │     │   └ ≥4.5:────────────────────── 23pct
139:     │ │     └ ≥47.5:GMLAT??
140:     │ │       ├ <52.5:KP??
141:     │ │       │ ├ <3.5:KP??
142:     │ │       │ │ ├ <2.5:──────────────────── 0pct
143:     │ │       │ │ └ ≥2.5:──────────────────── 05pct
144:     │ │       │ └ ≥3.5:KP??
145:     │ │       │   ├ <4.5:──────────────────── 14pct
146:     │ │       │   └ ≥4.5:──────────────────── 23pct
147:     │ │       └ ≥52.5:KP??
148:     │ │         ├ <3.5:KP??
149:     │ │         │ ├ <2.5:────────────────── 0pct
150:     │ │         │ └ ≥2.5:────────────────── 05pct
151:     │ │         └ ≥3.5:KP??
152:     │ │           ├ <4.5:────────────────── 14pct
153:     │ │           └ ≥4.5:────────────────── 23pct
```

```
│ └ ≥5.5:GMLAT??
│   ├ <42.5:GMLAT??
│   │ ├ <37.5:──────────────────────────────── NoneLatOOB
│   │ └ ≥37.5:──────────────────────────────── 0pct
│   └ ≥42.5:GMLAT??
│     ├ <47.5:KP??
│     │ ├ <7.5:KP??
│     │ │ ├ <6.5:──────────────────────────── 33pct
│     │ │ └ ≥6.5:──────────────────────────── 41pct
│     │ └ ≥7.5:KP??
│     │   ├ <8.5:──────────────────────────── 50pct
│     │   └ ≥8.5:──────────────────────────── 60pct
│     └ ≥47.5:GMLAT??
│       ├ <52.5:KP??
│       │ ├ <7.5:KP??
│       │ │ ├ <6.5:────────────────────────── 33pct
│       │ │ └ ≥6.5:────────────────────────── 41pct
│       │ └ ≥7.5:KP??
│       │   ├ <8.5:────────────────────────── 50pct
│       │   └ ≥8.5:────────────────────────── 60pct
│       └ ≥52.5:KP??
│         ├ <7.5:KP??
│         │ ├ <6.5:────────────────────────── 33pct
│         │ └ ≥6.5:────────────────────────── 41pct
│         └ ≥7.5:KP??
│           ├ <8.5:────────────────────────── 50pct
│           └ ≥8.5:────────────────────────── 60pct
└ ≥57.5:KP??
  ├ <5.5:GMLAT??
  │ ├ <62.5:KP??
  │ │ ├ <4.5:──────────────────────────────── 0pct
  │ │ └ ≥4.5:──────────────────────────────── 03pct
  │ └ ≥62.5:───────────────────────────────── 0pct
  └ ≥5.5:GMLAT??
    ├ <62.5:KP??
    │ ├ <7.5:KP??
    │ │ ├ <6.5:────────────────────────────── 13pct
    │ │ └ ≥6.5:────────────────────────────── 21pct
    │ └ ≥7.5:KP??
    │   ├ <8.5:────────────────────────────── 30pct
    │   └ ≥8.5:────────────────────────────── 40pct
    └ ≥62.5:───────────────────────────────── 0pct
```

#ISDur

```
    Rule for knowledge base ISDur                     11:01 am  07/15/1992

    MEMO
 1: ISPROB??
 2: ├Low:──────────────────────────────────────────────── MinimalTime
 3: ├Med:──────────────────────────────────────────────── MinimalTime
 4: └High:KP??
 5:       ├ <3.5:──────────────────────────────────────── 0to1Hr
 6:       └ ≥3.5:GMLAT??
 7:              ├ <57.5:KP??
 8:              │       ├ <6.5:GMLAT??
 9:              │       │       ├ <42.5:──────────────── 02Hrs
10:              │       │       └ ≥42.5:GMLAT??
11:              │       │               ├ <47.5:──────── 07Hrs
12:              │       │               └ ≥47.5:GMLAT??
13:              │       │                       ├ <52.5:─── 15Hrs
14:              │       │                       └ ≥52.5:─── 20Hrs
15:              │       └ ≥6.5:GMLAT??
16:              │               ├ <42.5:──────────────── 02Hrs
17:              │               └ ≥42.5:GMLAT??
18:              │                       ├ <47.5:──────── 07Hrs
19:              │                       └ ≥47.5:GMLAT??
20:              │                               ├ <52.5:─── 15Hrs
21:              │                               └ ≥52.5:─── 20Hrs
22:              └ ≥57.5:KP??
23:                      ├ <6.5:GMLAT??
24:                      │       ├ <72.5:GMLAT??
25:                      │       │       ├ <62.5:──────── 24Hrs
26:                      │       │       └ ≥62.5:GMLAT??
27:                      │       │               ├ <67.5:─── 28Hrs
28:                      │       │               └ ≥67.5:─── 24Hrs
29:                      │       └ ≥72.5:GMLAT??
30:                      │               ├ <82.5:GMLAT??
31:                      │               │       ├ <77.5:─── 18Hrs
32:                      │               │       └ ≥77.5:─── 14Hrs
33:                      │               └ ≥82.5:──────── 05Hrs
34:                      └ ≥6.5:GMLAT??
35:                              ├ <72.5:GMLAT??
36:                              │       ├ <62.5:──────── 24Hrs
37:                              │       └ ≥62.5:GMLAT??
38:                              │               ├ <67.5:─── 28Hrs
39:                              │               └ ≥67.5:─── 24Hrs
40:                              └ ≥72.5:GMLAT??
41:                                      ├ <82.5:GMLAT??
42:                                      │       ├ <77.5:─── 18Hrs
43:                                      │       └ ≥77.5:─── 14Hrs
44:                                      └ ≥82.5:──────── 05Hrs
```

#TEChange

Rule for knowledge base TEChange 11:01 am 07/15/1992

```
MEMO
#TPMPO??
├zero:───────────────────────────────────────────────── nil
├1to3hrs:TODCUR??
│                ├Sunrise:───────────────────────────── 12pct
│                ├Morning:───────────────────────────── 5pct
│                ├Noon:──────────────────────────────── 10pct
│                ├Afternoon:─────────────────────────── 12pct
│                ├Sunset:────────────────────────────── 10pct
│                ├PreMNight:─────────────────────────── 15pct
│                ├MidNight:──────────────────────────── neg9pct
│                └PostMNight:────────────────────────── nil
├4to6hrs:TODCUR??
│                ├Sunrise:───────────────────────────── 10pct
│                ├Morning:───────────────────────────── 30pct
│                ├Noon:──────────────────────────────── 40pct
│                ├Afternoon:─────────────────────────── 35pct
│                ├Sunset:────────────────────────────── 40pct
│                ├PreMNight:─────────────────────────── 45pct
│                ├MidNight:──────────────────────────── 5pct
│                └PostMNight:────────────────────────── 12pct
├7to9hrs:TODCUR??
│                ├Sunrise:───────────────────────────── neg9pct
│                ├Morning:───────────────────────────── neg14pct
│                ├Noon:──────────────────────────────── 35pct
│                ├Afternoon:─────────────────────────── 36pct
│                ├Sunset:────────────────────────────── 45pct
│                ├PreMNight:─────────────────────────── 31pct
│                ├MidNight:──────────────────────────── 25pct
│                └PostMNight:────────────────────────── neg10pct
├10to12hrs:TODCUR??
│                  ├Sunrise:─────────────────────────── neg7pct
│                  ├Morning:─────────────────────────── neg10pct
│                  ├Noon:────────────────────────────── neg12pct
│                  ├Afternoon:───────────────────────── 30pct
│                  ├Sunset:──────────────────────────── 25pct
│                  ├PreMNight:───────────────────────── 5pct
│                  ├MidNight:────────────────────────── 3pct
│                  └PostMNight:──────────────────────── neg5pct
├13to15hrs:TODCUR??
│                  ├Sunrise:─────────────────────────── neg12pct
│                  ├Morning:─────────────────────────── neg15pct
│                  ├Noon:────────────────────────────── neg10pct
│                  ├Afternoon:───────────────────────── neg15pct
│                  ├Sunset:──────────────────────────── 30pct
│                  ├PreMNight:───────────────────────── nil
│                  ├MidNight:────────────────────────── neg10pct
│                  └PostMNight:──────────────────────── neg23pct
```

```
├16to21hrs:TODCUR??
│          ├Sunrise:──────────────────────────── neg15pct
│          ├Morning:──────────────────────────── neg7pct
│          ├Noon:─────────────────────────────── neg9pct
│          ├Afternoon:────────────────────────── neg11pct
│          ├Sunset:───────────────────────────── neg7pct
│          ├PreMNight:────────────────────────── 3pct
│          ├MidNight:─────────────────────────── neg7pct
│          └PostMNight:───────────────────────── neg25pct
├22to30hrs:TODCUR??
│          ├Sunrise:──────────────────────────── neg13pct
│          ├Morning:──────────────────────────── neg6pct
│          ├Noon:─────────────────────────────── neg14pct
│          ├Afternoon:────────────────────────── neg10pct
│          ├Sunset:───────────────────────────── neg10pct
│          ├PreMNight:────────────────────────── neg15pct
│          ├MidNight:─────────────────────────── neg23pct
│          └PostMNight:───────────────────────── neg20pct
├31to42hrs:TODCUR??
│          ├Sunrise:──────────────────────────── neg22pct
│          ├Morning:──────────────────────────── neg12pct
│          ├Noon:─────────────────────────────── neg7pct
│          ├Afternoon:────────────────────────── neg5pct
│          ├Sunset:───────────────────────────── neg12pct
│          ├PreMNight:────────────────────────── neg17pct
│          ├MidNight:─────────────────────────── neg30pct
│          └PostMNight:───────────────────────── neg35pct
├43to66hrs:TODCUR??
│          ├Sunrise:──────────────────────────── neg18pct
│          ├Morning:──────────────────────────── neg8pct
│          ├Noon:─────────────────────────────── neg11pct
│          ├Afternoon:────────────────────────── neg4pct
│          ├Sunset:───────────────────────────── neg9pct
│          ├PreMNight:────────────────────────── neg11pct
│          ├MidNight:─────────────────────────── neg16pct
│          └PostMNight:───────────────────────── neg30pct
└67to99hrs:TODCUR??
           ├Sunrise:──────────────────────────── neg8pct
           ├Morning:──────────────────────────── neg4pct
           ├Noon:─────────────────────────────── nil
           ├Afternoon:────────────────────────── nil
           ├Sunset:───────────────────────────── neg5pct
           ├PreMNight:────────────────────────── neg6pct
           ├MidNight:─────────────────────────── neg11pct
           └PostMNight:───────────────────────── neg9pct
```

#TPMPO

Rule for knowledge base TPMPO   9:19 am 07/07/1992

```
TPFH??
├ <37.:TPFH??
│         ├ <28.:TPFH??
│         │         ├ <24.:──────────────────────────────── zero
│         │         └ ≥24.:──────────────────────────────── 1to3hrs
│         └ ≥28.:TPFH??
│                   ├ <31.:──────────────────────────────── 4to6hrs
│                   └ ≥31.:TPFH??
│                             ├ <34.:────────────────────── 7to9hrs
│                             └ ≥34.:────────────────────── 10to12hrs
└ ≥37.:TPFH??
          ├ <55.:TPFH??
          │         ├ <40.:──────────────────────────────── 13to15hrs
          │         └ ≥40.:TPFH??
          │                   ├ <46.:────────────────────── 16to21hrs
          │                   └ ≥46.:────────────────────── 22to30hrs
          └ ≥55.:TPFH??
                    ├ <67.:──────────────────────────────── 31to42hrs
                    └ ≥67.:TPFH??
                              ├ <91.:────────────────────── 43to66hrs
                              └ ≥91.:────────────────────── 67to99hrs
```

#2FCAur

Rule for knowledge base 2FCAur 11:01 am 07/15/1992

```
    MEMO
 1: EVAUR??
 2: ├Likely:──────────────────────────────────────── #FCAur
 3: └NotLikely:───────────────────────────────────── ~Return
```

#FCAur

Rule for knowledge base FCAur 11:01 am 07/15/1992

```
MEMO
GMLAT??
├ <59.:──────────────────────────────────────────────── <none>
└ ≥59.:KP??
       ├ <4.5:KP??
       │      ├ <1.5:GMLAT??
       │      │      ├ <73.:──────────────────────────── 1.0
       │      │      └ ≥73.:──────────────────────────── <none>
       │      └ ≥1.5:GMLAT??
       │             ├ <67.:GMLAT??
       │             │      ├ <61.:KP??
       │             │      │      ├ <2.5:──────────── 0.1
       │             │      │      └ ≥2.5:KP??
       │             │      │             ├ <3.5:──── 2.1
       │             │      │             └ ≥3.5:──── 3.5
       │             │      └ ≥61.:KP??
       │             │             ├ <2.5:GMLAT??
       │             │             │      ├ <63.:──── 2.5
       │             │             │      └ ≥63.:GMLAT??
       │             │             │             ├ <65.:──── 3.7
       │             │             │             └ ≥65.:──── 3.5
       │             │             └ ≥2.5:KP??
       │             │                    ├ <3.5:GMLAT??
       │             │                    │      ├ <63.:──── 4.1
       │             │                    │      └ ≥63.:GMLAT??
       │             │                    │             ├ <65.:─ 4.2
       │             │                    │             └ ≥65.:─ 3.7
       │             │                    └ ≥3.5:GMLAT??
       │             │                           ├ <65.:──── 4.8
       │             │                           └ ≥65.:──── 4.1
       │             └ ≥67.:GMLAT??
       │                    ├ <69.:KP??
       │                    │      ├ <2.5:──────────── 2.5
       │                    │      └ ≥2.5:KP??
       │                    │             ├ <3.5:──── 2.9
       │                    │             └ ≥3.5:──── 3.0
       │                    └ ≥69.:GMLAT??
       │                           ├ <71.:KP??
       │                           │      ├ <2.5:──── 2.0
       │                           │      └ ≥2.5:──── 2.1
       │                           └ ≥71.:──────────── 1.2
       │
```

```
└ ≥4.5:GMLAT??
    ├ <67.:GMLAT??
    │   ├ <63.:GMLAT??
    │   │   ├ <61.:KP??
    │   │   │   ├ <5.5:──────── 5.5
    │   │   │   └ ≥5.5:KP??
    │   │   │       ├ <6.5:──── 6.0
    │   │   │       └ ≥6.5:KP??
    │   │   │           ├ <8.5:──── 8(est)
    │   │   │           └ ≥8.5:──── 6.0
    │   │   └ ≥61.:KP??
    │   │       ├ <6.5:──────── 5.7
    │   │       └ ≥6.5:KP??
    │   │           ├ <8.5:──── 10(est)
    │   │           └ ≥8.5:──── 5.7
    │   └ ≥63.:GMLAT??
    │       ├ <65.:KP??
    │       │   ├ <6.5:──────── 5.3
    │       │   └ ≥6.5:KP??
    │       │       ├ <8.5:──── 11(est)
    │       │       └ ≥8.5:──── 5.3
    │       └ ≥65.:KP??
    │           ├ <6.5:──────── 4.6
    │           └ ≥6.5:KP??
    │               ├ <8.5:──── 9(est)
    │               └ ≥8.5:──── 4.6
    └ ≥67.:GMLAT??
        ├ <71.:GMLAT??
        │   ├ <69.:KP??
        │   │   ├ <6.5:──────── 3.5
        │   │   └ ≥6.5:KP??
        │   │       ├ <8.5:──── 7(est)
        │   │       └ ≥8.5:──── 3.5
        │   └ ≥69.:KP??
        │       ├ <6.5:──────── 2.5
        │       └ ≥6.5:KP??
        │           ├ <8.5:──── 5(est)
        │           └ ≥8.5:──── 2.5
        └ ≥71.:GMLAT??
            ├ <73.:KP??
            │   ├ <5.5:──────── 1.2
            │   └ ≥5.5:KP??
            │       ├ <6.5:──── 6.0
            │       └ ≥6.5:KP??
            │           ├ <8.5:──── 3(est)
            │           └ ≥8.5:──── 6.0
            └ ≥73.:──────────────── <none>
```

#2FCAZA

Rule for knowledge base 2FCAZA 9:22 am 07/07/1992

```
MEMO
1: EVAZA??
2: ├Likely:──────────────────────────────── #FCAZA
3: └NotLikely:───────────────────────────── ~Return
```

#FCAZA

```
    Rule for knowledge base FCAZA                9:25 am  07/07/1992

    MEMO
 1: #AZAQ1??
 2: └:#2AZAABS??
 3:    └:──────────────────────────────────────────── no_data
```

#AZAQ1

Rule for knowledge base AZAQ1 9:23 am 07/07/1992

```
MEMO
GLT??
├00:GMLAT??
│      ├ <73.:GMLAT??
│      │      ├ <65.:──────────────────────────────── 0
│      │      └ ≥65.:#APRANGE??
│      │             ├A:───────────────────────────── 0
│      │             ├B:GMLAT??
│      │             │    ├ <70.:──────────────────── 0
│      │             │    └ ≥70.:──────────────────── 5
│      │             ├C:───────────────────────────── 10
│      │             └D:───────────────────────────── 10
│      └ ≥73.:GMLAT??
│             ├ <75.:#APRANGE??
│             │      ├A:───────────────────────────── 0
│             │      ├B:───────────────────────────── 0
│             │      ├C:───────────────────────────── 5
│             │      └D:───────────────────────────── 5
│             └ ≥75.:──────────────────────────────── 0
├03:GMLAT??
│      ├ <75.:GMLAT??
│      │      ├ <65.:#APRANGE??
│      │      │      ├A:───────────────────────────── 0
│      │      │      ├B:───────────────────────────── 0
│      │      │      ├C:───────────────────────────── 0
│      │      │      └D:───────────────────────────── 5
│      │      └ ≥65.:#APRANGE??
│      │             ├A:GMLAT??
│      │             │    ├ <73.:──────────────────── 5
│      │             │    └ ≥73.:──────────────────── 0
│      │             ├B:───────────────────────────── 5
│      │             ├C:GMLAT??
│      │             │    ├ <70.:──────────────────── 15
│      │             │    └ ≥70.:GMLAT??
│      │             │           ├ <73.:───────────── 10
│      │             │           └ ≥73.:───────────── 5
│      │             └D:GMLAT??
│      │                  ├ <70.:──────────────────── 20
│      │                  └ ≥70.:GMLAT??
│      │                         ├ <73.:───────────── 10
│      │                         └ ≥73.:───────────── 5
│      └ ≥75.:─────────────────────────────────────── 0
```

```
├06:GMLAT??
│        ├ <75.:GMLAT??
│        │        ├ <65.:#APRANGE??
│        │        │        ├A:──────────────────────── 0
│        │        │        ├B:──────────────────────── 0
│        │        │        ├C:──────────────────────── 0
│        │        │        └D:──────────────────────── 5
│        │        └ ≥65.:#APRANGE??
│        │                 ├A:──────────────────────── 5
│        │                 ├B:GMLAT??
│        │                 │    ├ <70.:─────────────── 5
│        │                 │    └ ≥70.:GMLAT??
│        │                 │             ├ <73.:────── 10
│        │                 │             └ ≥73.:────── 5
│        │                 ├C:GMLAT??
│        │                 │    ├ <73.:─────────────── 15
│        │                 │    └ ≥73.:─────────────── 10
│        │                 └D:GMLAT??
│        │                      ├ <70.:─────────────── 25
│        │                      └ ≥70.:GMLAT??
│        │                               ├ <73.:────── 15
│        │                               └ ≥73.:────── 10
│        └ ≥75.:────────────────────────────────────── 0
├09:GMLAT??
│        ├ <70.:#APRANGE??
│        │        ├A:GMLAT??
│        │        │    ├ <65.:──────────────────────── 0
│        │        │    └ ≥65.:──────────────────────── 5
│        │        ├B:GMLAT??
│        │        │    ├ <65.:──────────────────────── 0
│        │        │    └ ≥65.:──────────────────────── 15
│        │        ├C:GMLAT??
│        │        │    ├ <65.:──────────────────────── 0
│        │        │    └ ≥65.:──────────────────────── 25
│        │        └D:GMLAT??
│        │             ├ <65.:──────────────────────── 5
│        │             └ ≥65.:──────────────────────── 30
│        └ ≥70.:GMLAT??
│                 ├ <75.:GMLAT??
│                 │        ├ <73.:#APRANGE??
│                 │        │        ├A:─────────────── 10
│                 │        │        ├B:─────────────── 10
│                 │        │        ├C:─────────────── 20
│                 │        │        └D:─────────────── 20
│                 │        └ ≥73.:#APRANGE??
│                 │                 ├A:─────────────── 10
│                 │                 ├B:─────────────── 5
│                 │                 ├C:─────────────── 10
│                 │                 └D:─────────────── 10
│                 └ ≥75.:#APRANGE??
│                          ├A:──────────────────────── 5
│                          ├B:──────────────────────── 0
│                          ├C:──────────────────────── 5
│                          └D:──────────────────────── 5
```

```
├12:#APRANGE??
│     ├A:GMLAT??
│     │    ├ <65.:─────────────────────────────────────────────── 0
│     │    └ ≥65.:GMLAT??
│     │              ├ <75.:──────────────────────────────────── 5
│     │              └ ≥75.:──────────────────────────────────── 0
│     ├B:GMLAT??
│     │    ├ <65.:─────────────────────────────────────────────── 0
│     │    └ ≥65.:GMLAT??
│     │              ├ <75.:GMLAT??
│     │              │         ├ <70.:─────────────────────────── 5
│     │              │         └ ≥70.:GMLAT??
│     │              │                   ├ <73.:───────────────── 10
│     │              │                   └ ≥73.:───────────────── 5
│     │              └ ≥75.:──────────────────────────────────── 0
│     ├C:GMLAT??
│     │    ├ <73.:GMLAT??
│     │    │         ├ <65.:──────────────────────────────────── 0
│     │    │         └ ≥65.:──────────────────────────────────── 15
│     │    └ ≥73.:GMLAT??
│     │              ├ <75.:──────────────────────────────────── 5
│     │              └ ≥75.:──────────────────────────────────── 0
│     └D:GMLAT??
│          ├ <70.:GMLAT??
│          │         ├ <65.:──────────────────────────────────── 5
│          │         └ ≥65.:──────────────────────────────────── 15
│          └ ≥70.:GMLAT??
│                    ├ <73.:──────────────────────────────────── 20
│                    └ ≥73.:GMLAT??
│                              ├ <75.:─────────────────────────── 10
│                              └ ≥75.:─────────────────────────── 5
├15:GMLAT??
│     ├ <73.:GMLAT??
│     │         ├ <65.:─────────────────────────────────────────── 0
│     │         └ ≥65.:#APRANGE??
│     │                   ├A:GMLAT??
│     │                   │    ├ <70.:─────────────────────────── 0
│     │                   │    └ ≥70.:─────────────────────────── 5
│     │                   ├B:──────────────────────────────────── 5
│     │                   ├C:GMLAT??
│     │                   │    ├ <70.:─────────────────────────── 10
│     │                   │    └ ≥70.:─────────────────────────── 5
│     │                   └D:GMLAT??
│     │                        ├ <70.:─────────────────────────── 10
│     │                        └ ≥70.:─────────────────────────── 0
│     └ ≥73.:───────────────────────────────────────────────────── 0
```

```
├18:GMLAT??
│      ├ <70.:#APRANGE??
│      │            ├A:──────────────────────────────── 0
│      │            ├B:──────────────────────────────── 0
│      │            ├C:──────────────────────────────── 0
│      │            └D:──────────────────────────────── 5
│      └ ≥70.:──────────────────────────────────────── 0
└21:GMLAT??
       ├ <70.:GMLAT??
       │            ├ <65.:─────────────────────────── 0
       │            └ ≥65.:#APRANGE??
       │                          ├A:────────────────── 0
       │                          ├B:────────────────── 0
       │                          ├C:────────────────── 0
       │                          └D:────────────────── 10
       └ ≥70.:GMLAT??
                    ├ <73.:#APRANGE??
                    │             ├A:────────────────── 0
                    │             ├B:────────────────── 0
                    │             ├C:────────────────── 0
                    │             └D:────────────────── 5
                    └ ≥73.:──────────────────────────── 0
```

#ApRange

Rule for knowledge base ApRange 11:02 am 07/15/1992

```
1: APINDEX??
2: ├ <15.:APINDEX??
3: │       ├ <10.:──────────────────────────── A
4: │       └ ≥10.:──────────────────────────── B
5: └ ≥15.:APINDEX??
6:         ├ <20.:──────────────────────────── C
7:         └ ≥20.:──────────────────────────── D
```

#2AZAAbs

Rule for knowledge base 2AZAAbs 11:02 am 07/15/1992

```
    MEMO
 1: SSN??
 2: ├ <5.:——————————————————————— #azaabsl
 3: └ ≥5.:——————————————————————— #azaabsh
```

#AZAAbsL

Rule for knowledge base AZAAbsL   11:02 am   07/15/1992

```
MEMO
#KA??
├0.0:──────────────────────────────────────── 0
├0.5:FOP??
│     ├ <7.5:FOP??
│     │       ├ <4.25:FOP??
│     │       │        ├ <3.25:FOP??
│     │       │        │        ├ <2.5:──────────────── 0
│     │       │        │        └ ≥2.5:──────────────── 32
│     │       │        └ ≥3.25:FOP??
│     │       │                 ├ <3.75:─────────────── 24
│     │       │                 └ ≥3.75:─────────────── 18
│     │       └ ≥4.25:FOP??
│     │                ├ <5.25:FOP??
│     │                │        ├ <4.75:─────────────── 14
│     │                │        └ ≥4.75:─────────────── 11
│     │                └ ≥5.25:FOP??
│     │                         ├ <5.75:─────────────── 10
│     │                         └ ≥5.75:FOP??
│     │                                  ├ <6.5:─────── 8
│     │                                  └ ≥6.5:─────── 6
│     └ ≥7.5:FOP??
│             ├ <13.:FOP??
│             │       ├ <9.5:────────────────────────── 4
│             │       └ ≥9.5:FOP??
│             │               ├ <11.:────────────────── 3
│             │               └ ≥11.:────────────────── 2
│             └ ≥13.:FOP??
│                     ├ <19.:────────────────────────── 1
│                     └ ≥19.:────────────────────────── 0
├1.0:FOP??
│     ├ <7.5:FOP??
│     │       ├ <4.25:FOP??
│     │       │        ├ <3.25:FOP??
│     │       │        │        ├ <2.5:──────────────── 0
│     │       │        │        └ ≥2.5:──────────────── 58
│     │       │        └ ≥3.25:FOP??
│     │       │                 ├ <3.75:─────────────── 48
│     │       │                 └ ≥3.75:─────────────── 36
│     │       └ ≥4.25:FOP??
│     │                ├ <5.25:FOP??
│     │                │        ├ <4.75:─────────────── 29
│     │                │        └ ≥4.75:─────────────── 23
│     │                └ ≥5.25:FOP??
│     │                         ├ <5.75:─────────────── 19
│     │                         └ ≥5.75:FOP??
│     │                                  ├ <6.5:─────── 16
│     │                                  └ ≥6.5:─────── 12
│     │
```

```
│    └ ≥7.5:FOP??
│         ├ <15.:FOP??
│         │    ├ <9.5:FOP??
│         │    │    ├ <8.5:──────────── 9
│         │    │    └ ≥8.5:──────────── 7
│         │    └ ≥9.5:FOP??
│         │         ├ <11.:──────────── 6
│         │         └ ≥11.:FOP??
│         │              ├ <13.:─────── 4
│         │              └ ≥13.:─────── 3
│         └ ≥15.:FOP??
│              ├ <19.:FOP??
│              │    ├ <17.:──────────── 2
│              │    └ ≥17.:──────────── 1
│              └ ≥19.:───────────────── 0
├1.5:FOP??
│    ├ <7.5:FOP??
│    │    ├ <4.25:FOP??
│    │    │    ├ <3.25:FOP??
│    │    │    │    ├ <2.5:──────────── 0
│    │    │    │    └ ≥2.5:──────────── 68
│    │    │    └ ≥3.25:FOP??
│    │    │         ├ <3.75:─────────── 58
│    │    │         └ ≥3.75:─────────── 48
│    │    └ ≥4.25:FOP??
│    │         ├ <5.25:FOP??
│    │         │    ├ <4.75:─────────── 43
│    │         │    └ ≥4.75:─────────── 35
│    │         └ ≥5.25:FOP??
│    │              ├ <5.75:─────────── 29
│    │              └ ≥5.75:FOP??
│    │                   ├ <6.5:─────── 24
│    │                   └ ≥6.5:─────── 18
│    └ ≥7.5:FOP??
│         ├ <17.:FOP??
│         │    ├ <11.:FOP??
│         │    │    ├ <8.5:──────────── 14
│         │    │    └ ≥8.5:FOP??
│         │    │         ├ <9.5:─────── 11
│         │    │         └ ≥9.5:─────── 8
│         │    └ ≥11.:FOP??
│         │         ├ <13.:──────────── 6
│         │         └ ≥13.:──────────── 4
│         └ ≥17.:FOP??
│              ├ <22.5:FOP??
│              │    ├ <19.:──────────── 3
│              │    └ ≥19.:──────────── 2
│              └ ≥22.5:FOP??
│                   ├ <25.5:─────────── 1
│                   └ ≥25.5:─────────── 0
```

```
 98: ├2.0:FOP??
 99: │     ├ <7.5:FOP??
100: │     │      ├ <4.25:FOP??
101: │     │      │      ├ <3.25:FOP??
102: │     │      │      │      ├ <2.5:──────────────── 0
103: │     │      │      │      └ ≥2.5:──────────────── 78
104: │     │      │      └ ≥3.25:FOP??
105: │     │      │             ├ <3.75:─────────────── 68
106: │     │      │             └ ≥3.75:─────────────── 58
107: │     │      └ ≥4.25:FOP??
108: │     │             ├ <5.25:FOP??
109: │     │             │      ├ <4.75:─────────────── 48
110: │     │             │      └ ≥4.75:─────────────── 47
111: │     │             └ ≥5.25:FOP??
112: │     │                    ├ <5.75:─────────────── 38
113: │     │                    └ ≥5.75:FOP??
114: │     │                           ├ <6.5:───────── 32
115: │     │                           └ ≥6.5:───────── 24
116: │     └ ≥7.5:FOP??
117: │            ├ <15.:FOP??
118: │            │      ├ <9.5:FOP??
119: │            │      │      ├ <8.5:──────────────── 18
120: │            │      │      └ ≥8.5:──────────────── 14
121: │            │      └ ≥9.5:FOP??
122: │            │             ├ <11.:──────────────── 11
123: │            │             └ ≥11.:FOP??
124: │            │                    ├ <13.:───────── 8
125: │            │                    └ ≥13.:───────── 6
126: │            └ ≥15.:FOP??
127: │                   ├ <19.:─────────────────────── 4
128: │                   └ ≥19.:FOP??
129: │                          ├ <22.5:─────────────── 3
130: │                          └ ≥22.5:FOP??
131: │                                 ├ <25.5:─────── 2
132: │                                 └ ≥25.5:─────── 0
133: └2.5:FOP??
134:       ├ <7.5:FOP??
135:       │      ├ <4.25:FOP??
136:       │      │      ├ <2.5:──────────────────────── 0
137:       │      │      └ ≥2.5:FOP??
138:       │      │             ├ <3.75:──────────────── 80
139:       │      │             └ ≥3.75:──────────────── 78
140:       │      └ ≥4.25:FOP??
141:       │             ├ <5.25:FOP??
142:       │             │      ├ <4.75:─────────────── 68
143:       │             │      └ ≥4.75:─────────────── 58
144:       │             └ ≥5.25:FOP??
145:       │                    ├ <5.75:─────────────── 48
146:       │                    └ ≥5.75:FOP??
147:       │                           ├ <6.5:───────── 41
148:       │                           └ ≥6.5:───────── 30
```

```
└ ≥7.5:FOP??
    ├ <15.:FOP??
    │   ├ <9.5:FOP??
    │   │   ├ <8.5:──────────────── 23
    │   │   └ ≥8.5:──────────────── 18
    │   └ ≥9.5:FOP??
    │       ├ <11.:──────────────── 14
    │       └ ≥11.:FOP??
    │           ├ <13.:──────────── 10
    │           └ ≥13.:──────────── 7
    └ ≥15.:FOP??
        ├ <19.:──────────────────── 5
        └ ≥19.:FOP??
            ├ <22.5:─────────────── 4
            └ ≥22.5:FOP??
                ├ <25.5:─────────── 2
                └ ≥25.5:─────────── 0
```

#AZAAbsH

Rule for knowledge base AZAAbsH 11:02 am 07/15/1992

```
MEMO
#KA??
├0.0:──────────────────────────────────────────── 0
├0.5:FOP??
│    ├ <7.5:FOP??
│    │      ├ <4.25:FOP??
│    │      │       ├ <3.25:FOP??
│    │      │       │       ├ <2.5:─────────────── 0
│    │      │       │       └ ≥2.5:─────────────── 54
│    │      │       └ ≥3.25:FOP??
│    │      │               ├ <3.75:────────────── 40
│    │      │               └ ≥3.75:────────────── 30
│    │      └ ≥4.25:FOP??
│    │              ├ <5.25:FOP??
│    │              │       ├ <4.75:────────────── 24
│    │              │       └ ≥4.75:────────────── 19
│    │              └ ≥5.25:FOP??
│    │                      ├ <5.75:────────────── 16
│    │                      └ ≥5.75:FOP??
│    │                              ├ <6.5:─────── 14
│    │                              └ ≥6.5:─────── 10
│    └ ≥7.5:FOP??
│           ├ <15.:FOP??
│           │      ├ <9.5:FOP??
│           │      │      ├ <8.5:───────────────── 7
│           │      │      └ ≥8.5:───────────────── 6
│           │      └ ≥9.5:FOP??
│           │             ├ <11.:───────────────── 5
│           │             └ ≥11.:───────────────── 3
│           └ ≥15.:FOP??
│                  ├ <22.5:─────────────────────── 2
│                  └ ≥22.5:FOP??
│                         ├ <25.5:──────────────── 1
│                         └ ≥25.5:──────────────── 0
├1.0:FOP??
│    ├ <7.5:FOP??
│    │      ├ <4.25:FOP??
│    │      │       ├ <2.5:─────────────────────── 0
│    │      │       └ ≥2.5:FOP??
│    │      │               ├ <3.75:────────────── 80
│    │      │               └ ≥3.75:────────────── 60
│    │      └ ≥4.25:FOP??
│    │              ├ <5.25:FOP??
│    │              │       ├ <4.75:────────────── 48
│    │              │       └ ≥4.75:────────────── 39
│    │              └ ≥5.25:FOP??
│    │                      ├ <5.75:────────────── 32
│    │                      └ ≥5.75:FOP??
│    │                              ├ <6.5:─────── 27
│    │                              └ ≥6.5:─────── 20
│    │
```

```
│      └ ≥7.5:FOP??
│             ├ <15.:FOP??
│             │      ├ <9.5:FOP??
│             │      │      ├ <8.5:───────────────── 15
│             │      │      └ ≥8.5:───────────────── 12
│             │      └ ≥9.5:FOP??
│             │             ├ <11.:───────────────── 10
│             │             └ ≥11.:FOP??
│             │                    ├ <13.:────────── 7
│             │                    └ ≥13.:────────── 5
│             └ ≥15.:FOP??
│                    ├ <22.5:FOP??
│                    │       ├ <17.:──────────────── 4
│                    │       └ ≥17.:──────────────── 3
│                    └ ≥22.5:FOP??
│                            ├ <25.5:─────────────── 2
│                            └ ≥25.5:─────────────── 0
├1.5:FOP??
│      ├ <7.5:FOP??
│      │      ├ <4.25:FOP??
│      │      │       ├ <2.5:─────────────────────── 0
│      │      │       └ ≥2.5:─────────────────────── 80
│      │      └ ≥4.25:FOP??
│      │              ├ <5.25:FOP??
│      │              │       ├ <4.75:────────────── 72
│      │              │       └ ≥4.75:────────────── 58
│      │              └ ≥5.25:FOP??
│      │                      ├ <5.75:────────────── 48
│      │                      └ ≥5.75:FOP??
│      │                              ├ <6.5:─────── 40
│      │                              └ ≥6.5:─────── 30
│      └ ≥7.5:FOP??
│             ├ <15.:FOP??
│             │      ├ <9.5:FOP??
│             │      │      ├ <8.5:───────────────── 23
│             │      │      └ ≥8.5:───────────────── 18
│             │      └ ≥9.5:FOP??
│             │             ├ <11.:───────────────── 14
│             │             └ ≥11.:FOP??
│             │                    ├ <13.:────────── 10
│             │                    └ ≥13.:────────── 7
│             └ ≥15.:FOP??
│                    ├ <19.:FOP??
│                    │      ├ <17.:───────────────── 6
│                    │      └ ≥17.:───────────────── 5
│                    └ ≥19.:FOP??
│                           ├ <22.5:──────────────── 3
│                           └ ≥22.5:FOP??
│                                   ├ <25.5:──────── 2
│                                   └ ≥25.5:──────── 0
```

```
├2.0:FOP??
│       ├ <7.5:FOP??
│       │         ├ <4.75:FOP??
│       │         │           ├ <2.5:──────────────────────── 0
│       │         │           └ ≥2.5:──────────────────────── 80
│       │         └ ≥4.75:FOP??
│       │                     ├ <5.75:FOP??
│       │                     │           ├ <5.25:─────────── 78
│       │                     │           └ ≥5.25:─────────── 64
│       │                     └ ≥5.75:FOP??
│       │                                 ├ <6.5:──────────── 54
│       │                                 └ ≥6.5:──────────── 40
│       └ ≥7.5:FOP??
│                 ├ <15.:FOP??
│                 │         ├ <9.5:FOP??
│                 │         │          ├ <8.5:─────────────── 30
│                 │         │          └ ≥8.5:─────────────── 24
│                 │         └ ≥9.5:FOP??
│                 │                    ├ <11.:─────────────── 19
│                 │                    └ ≥11.:FOP??
│                 │                               ├ <13.:──── 14
│                 │                               └ ≥13.:──── 10
│                 └ ≥15.:FOP??
│                           ├ <19.:FOP??
│                           │          ├ <17.:─────────────── 7
│                           │          └ ≥17.:─────────────── 6
│                           └ ≥19.:FOP??
│                                      ├ <22.5:────────────── 5
│                                      └ ≥22.5:FOP??
│                                                 ├ <25.5:─── 3
│                                                 └ ≥25.5:─── 0
└2.5:FOP??
        ├ <7.5:FOP??
        │         ├ <5.75:FOP??
        │         │           ├ <2.5:──────────────────────── 0
        │         │           └ ≥2.5:──────────────────────── 80
        │         └ ≥5.75:FOP??
        │                     ├ <6.5:──────────────────────── 68
        │                     └ ≥6.5:──────────────────────── 50
        └ ≥7.5:FOP??
                  ├ <15.:FOP??
                  │         ├ <9.5:FOP??
                  │         │          ├ <8.5:─────────────── 38
                  │         │          └ ≥8.5:─────────────── 30
                  │         └ ≥9.5:FOP??
                  │                    ├ <11.:─────────────── 24
                  │                    └ ≥11.:FOP??
                  │                               ├ <13.:──── 17
                  │                               └ ≥13.:──── 12
                  │
```

```
└ ≥15.:FOP??
          ├ <19.:FOP??
          │         ├ <17.:──────────────────────── 9
          │         └ ≥17.:──────────────────────── 8
          └ ≥19.:FOP??
                    ├ <22.5:─────────────────────── 6
                    └ ≥22.5:FOP??
                              ├ <25.5:───────────── 4
                              └ ≥25.5:───────────── 0
```

#Ka

Rule for knowledge base Ka   11:02 am   07/15/1992

```
MEMO
GGLON??
├ <-105.:GGLAT??
│ ├ <57.5:GGLON??
│ │ ├ <-135.:───────────────────────────── 0.0
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37:   │ │ │ ├ <-75.:GGLAT??
38:   │ │ │ │ ├ <52.5:GGLAT??
39:   │ │ │ │ │ ├ <47.5:──────────────────────────── 0.0
40:   │ │ │ │ │ └ ≥47.5:──────────────────────────── 0.5
41:   │ │ │ │ └ ≥52.5:────────────────────────────── 1.5
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48:   │ │   ├ <52.5:──────────────────────────────── 0.0
49:   │ │   └ ≥52.5:GGLAT??
50:   │ │     ├ <57.5:────────────────────────────── 1.0
51:   │ │     └ ≥57.5:────────────────────────────── 2.5
52:   │ └ ≥-15.:GGLON??
53:   │   ├ <15.:GGLAT??
54:   │   │ ├ <57.5:────────────────────────────── 0.0
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56:   │   └ ≥15.:────────────────────────────────── 0.0
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60:    │ │ ├ <-75.:GGLAT??
61:    │ │ │ ├ <77.5:GGLAT??
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64:    │ │ │ └ ≥77.5:────────────────────────── 0.0
65:    │ │ └ ≥-75.:GGLAT??
66:    │ │   ├ <72.5:GGLAT??
67:    │ │   │ ├ <67.5:──────────────────────── 1.0
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70:    │ └ ≥-45.:GGLAT??
71:    │   ├ <82.5:GGLAT??
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73:    │   │ └ ≥67.5:────────────────────────── 0.5
74:    │   └ ≥82.5:──────────────────────────── 0.0
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76:      ├ <45.:GGLON??
77:      │ ├ <15.:GGLAT??
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79:      │ │ │ ├ <67.5:──────────────────────── 2.5
80:      │ │ │ └ ≥67.5:──────────────────────── 1.5
81:      │ │ └ ≥72.5:────────────────────────── 0.5
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 95:   │   │   │   │   └ ≥67.5:GGLAT??
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 97:   │   │   │   │       └ ≥72.5:──────────── 1.0
 98:   │   │   │   └ ≥77.5:──────────────────── 0.5
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103:   │   │       └ ≥77.5:──────────────────── 0.5
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105:   │       ├ <135.:GGLAT??
106:   │       │   ├ <77.5:GGLAT??
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109:   │       │   │       ├ <72.5:──────────── 1.5
110:   │       │   │       └ ≥72.5:──────────── 1.0
111:   │       │   └ ≥77.5:──────────────────── 0.5
112:   │       └ ≥135.:GGLAT??
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116:   │           │       ├ <72.5:──────────── 1.5
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118:   │           └ ≥77.5:──────────────────── 0.5
119:   └ ≥165.:GGLAT??
120:       ├ <77.5:GGLAT??
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#FCOut

Rule for knowledge base FCOut 11:02 am 07/15/1992

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2: └:──────────────────────────────────── no_data
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This technical document, actually a system design document or functional description document, covers the Disturbance Impact Assessment System (DIAS). This system is a computer software package designed to assess the effects of solar flares on HF radio communications. The document describes its software functions and their interrelationships. Specifically, the document (1) provides background information on the effects of high levels of solar activity on high-latitude HF missions, (2) outlines the architecture of DIAS, and (3) defines the product that DIAS provides to the user.

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